EXHIBIT A

US010136503B2

(12) **United States Patent**
Chen

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(45) **Date of Patent: *Nov. 20, 2018**

(54) **MICROCONTROLLER-BASED MULTIFUNCTIONAL ELECTRONIC SWITCH AND LIGHTING APPARATUS HAVING THE SAME**

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(72) Inventor: **Chia-Teh Chen**, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **15/702,837**

(22) Filed: **Sep. 13, 2017**

(65) **Prior Publication Data**

US 2018/0070425 A1 Mar. 8, 2018

Related U.S. Application Data

(63) Continuation of application No. 15/292,395, filed on Oct. 13, 2016, now Pat. No. 9,795,008, which is a (Continued)

(30) **Foreign Application Priority Data**

Oct. 15, 2012 (TW) .... 101137918 A

(51) **Int. Cl.**
H05B 37/02 (2006.01)
H03K 17/13 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC .... ***H05B 37/0227*** (2013.01); ***H03K 17/133*** (2013.01); ***H03K 17/941*** (2013.01); (Continued)

(58) **Field of Classification Search**
CPC H05B 37/0227; H05B 33/0815; H05B 33/0854
(Continued)

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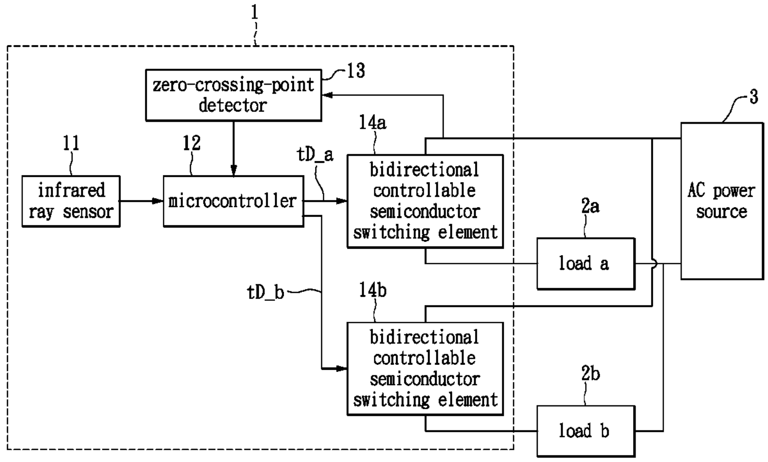
Primary Examiner — Thuy Vinh Tran
(74) *Attorney, Agent, or Firm* — Li & Cai Intellectual Property (USA) Office

(57) **ABSTRACT**

A microcontroller-based multifunctional electronic switch for lighting control uses a detection device to sense and convert at least one external control signal into at least one message carrying sensing signal interpretable to a microcontroller. Based on a signal format of the message carrying sensing signal received, the microcontroller recognizes working mode chosen by the external control signal and thereby executes an appropriate lighting control process. The system and method of the present invention may be equally applicable to detection design, such as touch less and direct touch interface implemented by infrared ray sensor, push button or wireless control device in conjunction with APP preloaded, for performing multiple working modes including on/off mode, dimming mode, color temperature tuning mode, color temperature switching mode, color temperature dim to warm mode, commanding mode for controlling a lighting family comprising a plurality of member lamps remotely located or delay shut off mode.

110 Claims, 19 Drawing Sheets



Related U.S. Application Data

continuation of application No. 15/095,540, filed on Apr. 11, 2016, now Pat. No. 9,497,834, which is a continuation of application No. 14/579,248, filed on Dec. 22, 2014, now Pat. No. 9,345,112, which is a continuation-in-part of application No. 13/792,002, filed on Mar. 9, 2013, now Pat. No. 8,947,000.

(51) **Int. Cl.**

H03K 17/94	(2006.01)
H05B 39/08	(2006.01)
H05B 33/08	(2006.01)
F21Y 115/10	(2016.01)
F21V 3/00	(2015.01)

(52) **U.S. Cl.**

CPC ***H05B 33/0815*** (2013.01); ***H05B 33/0854*** (2013.01); ***H05B 33/0863*** (2013.01); ***H05B 37/0272*** (2013.01); ***H05B 39/08*** (2013.01); *F21V 3/00* (2013.01); *F21Y 2115/10* (2016.08); *Y02B 20/44* (2013.01); *Y10T 307/25* (2015.04); *Y10T 307/766* (2015.04); *Y10T 307/773* (2015.04); *Y10T 307/826* (2015.04)

(58) **Field of Classification Search**

USPC 315/159, 360, 362; 340/541, 567

See application file for complete search history.

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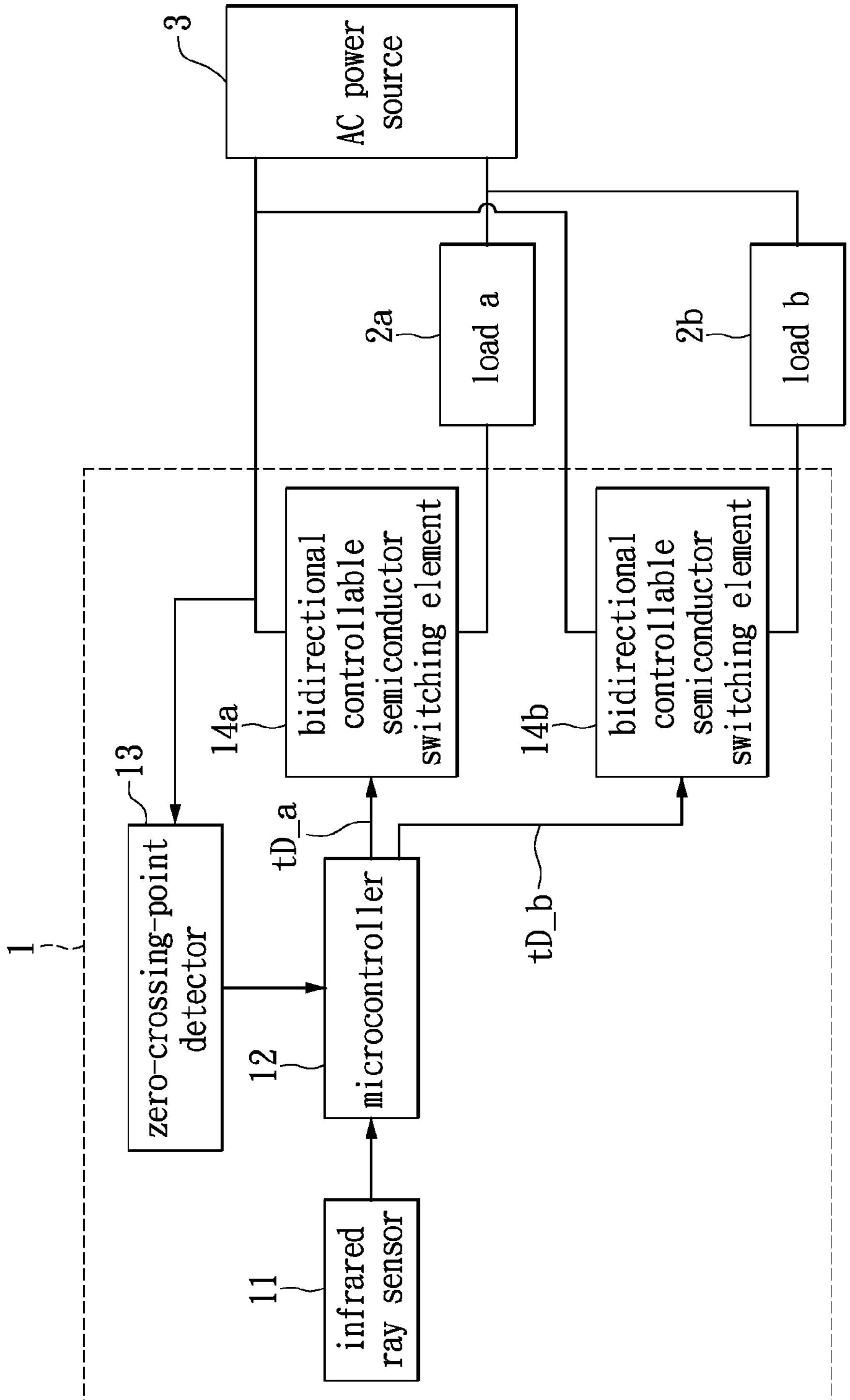
3
AC power source
2a
load a
2b
load b
1
13
zero-crossing-point detector
14a
bidirectional controllable semiconductor switching element
14b
bidirectional controllable semiconductor switching element
tD_a
tD_b
12
microcontroller
11
infrared ray sensor

FIG. 1

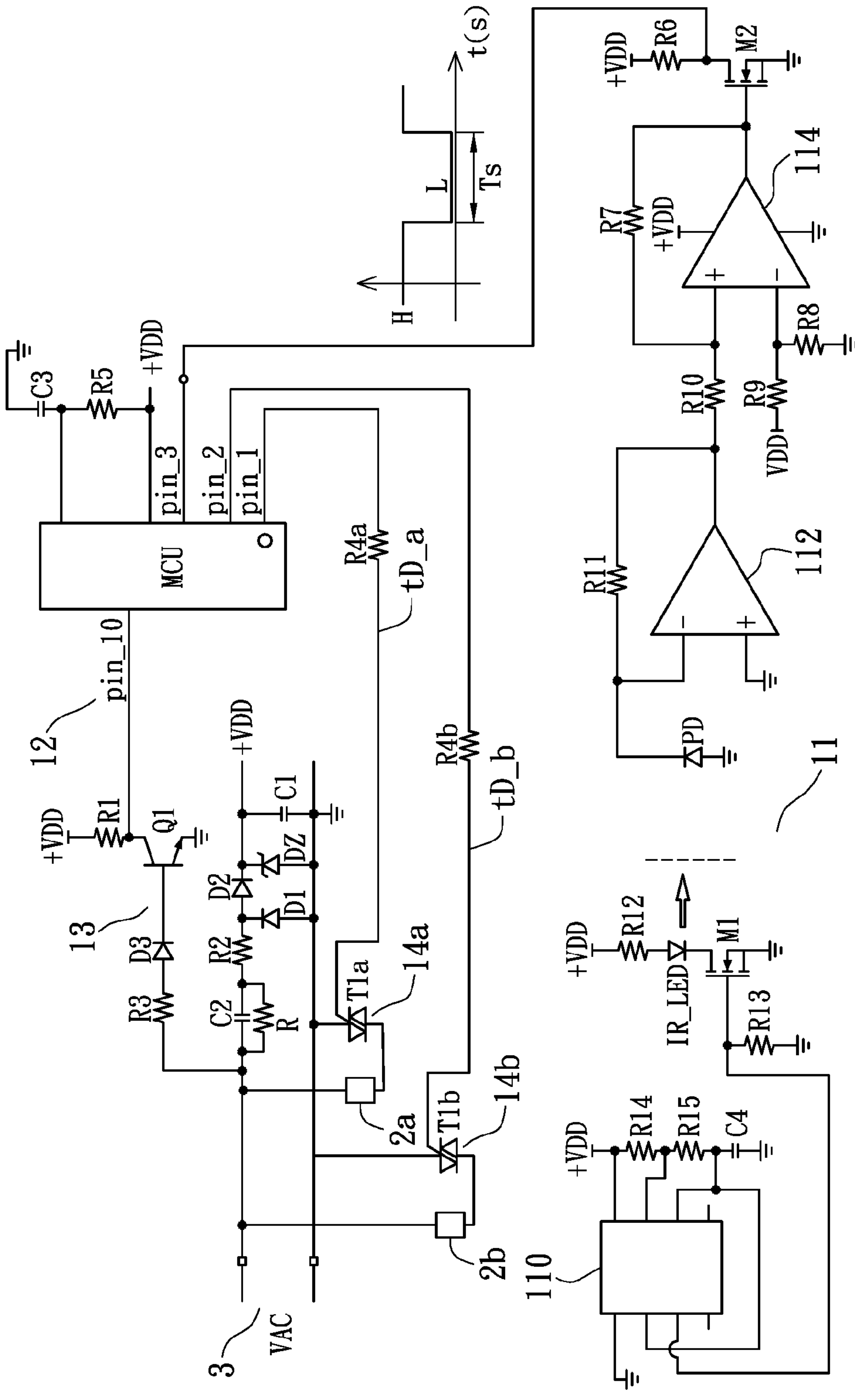
MCU
pin_1
pin_2
pin_3
pin_10
+VDD
R1
R2
R3
R4a
R4b
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
C1
C2
C3
C4
D1
D2
D3
DZ
Q1
M1
M2
T1a
T1b
tD_a
tD_b
PD
IR_LED
VDD
VAC
R
H
L
Ts
t(s)
2a
2b
3
11
12
13
14a
14b
110
112
114

FIG. 2

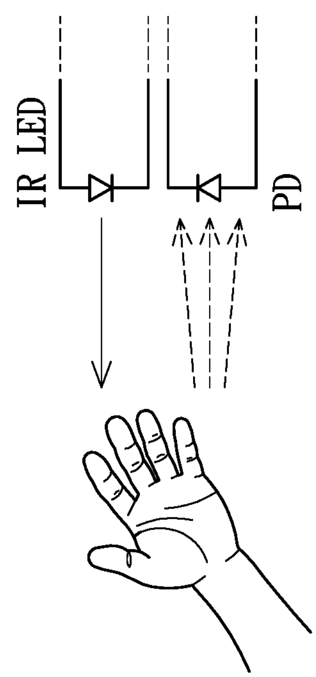

FIG. 3A

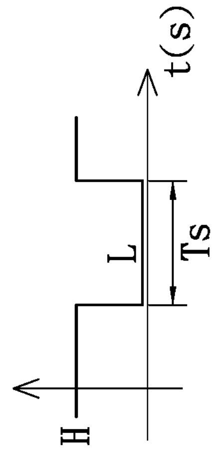

FIG. 3B

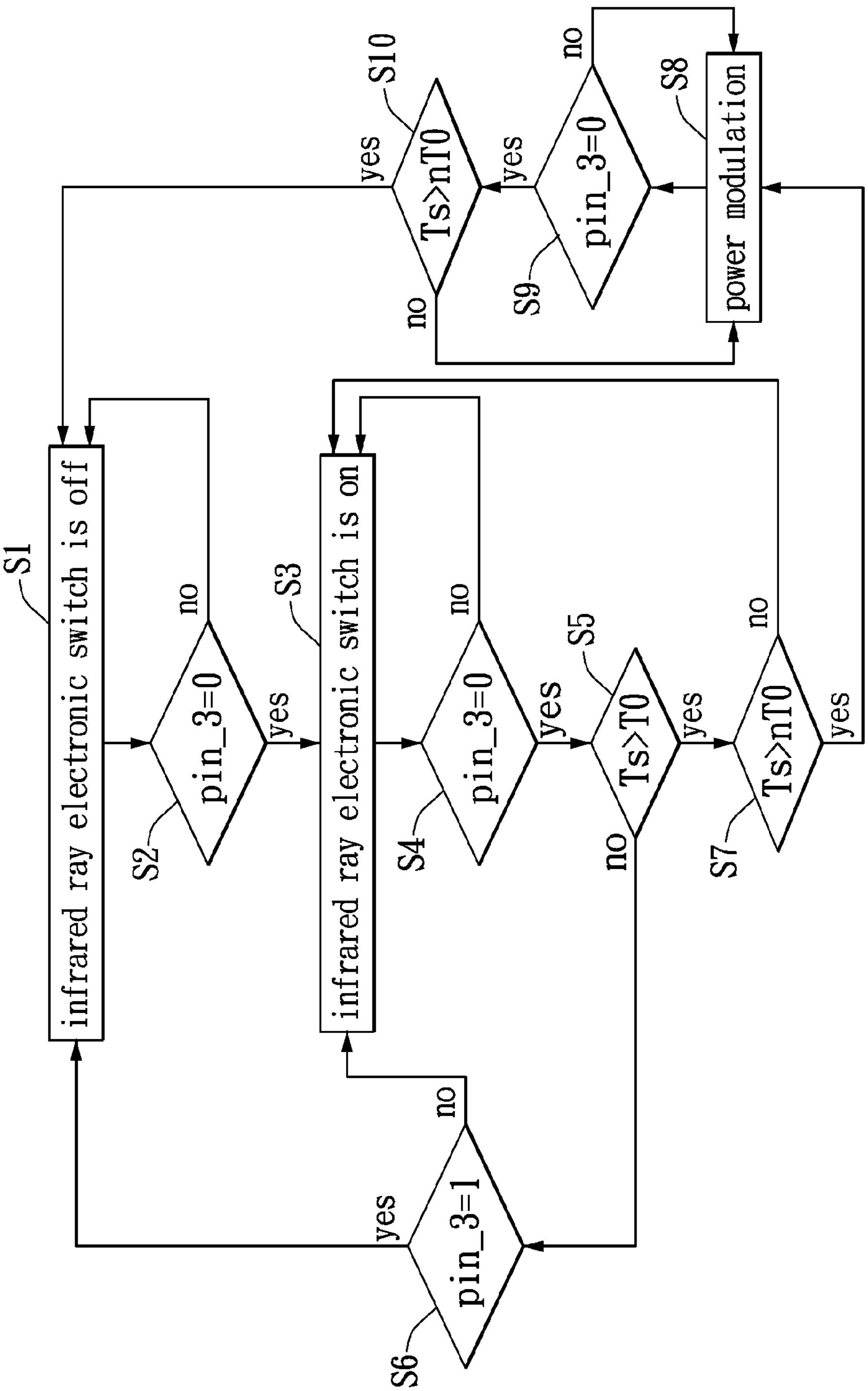
S1
infrared ray electronic switch is off
S2
pin_3=0
no
yes
S3
infrared ray electronic switch is on
S4
pin_3=0
no
yes
S5
Ts>T0
no
yes
S6
pin_3=1
no
yes
S7
Ts>nT0
no
yes
S8
power modulation
S9
pin_3=0
no
yes
S10
Ts>nT0
no
yes

FIG. 4

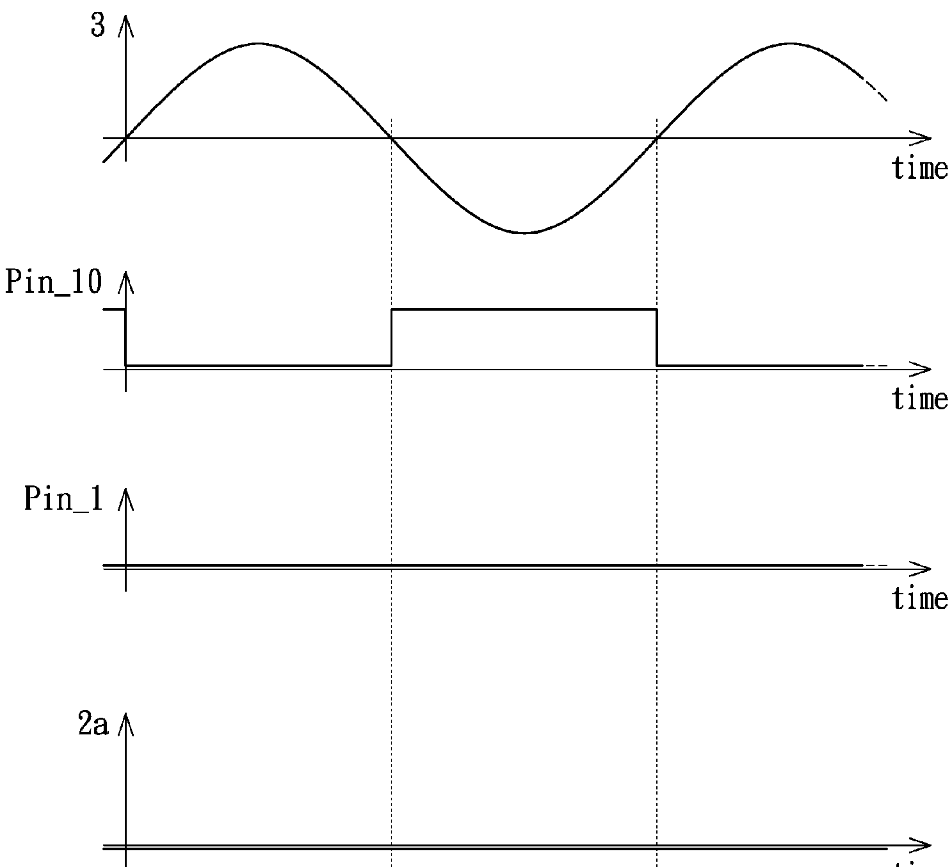

FIG. 5

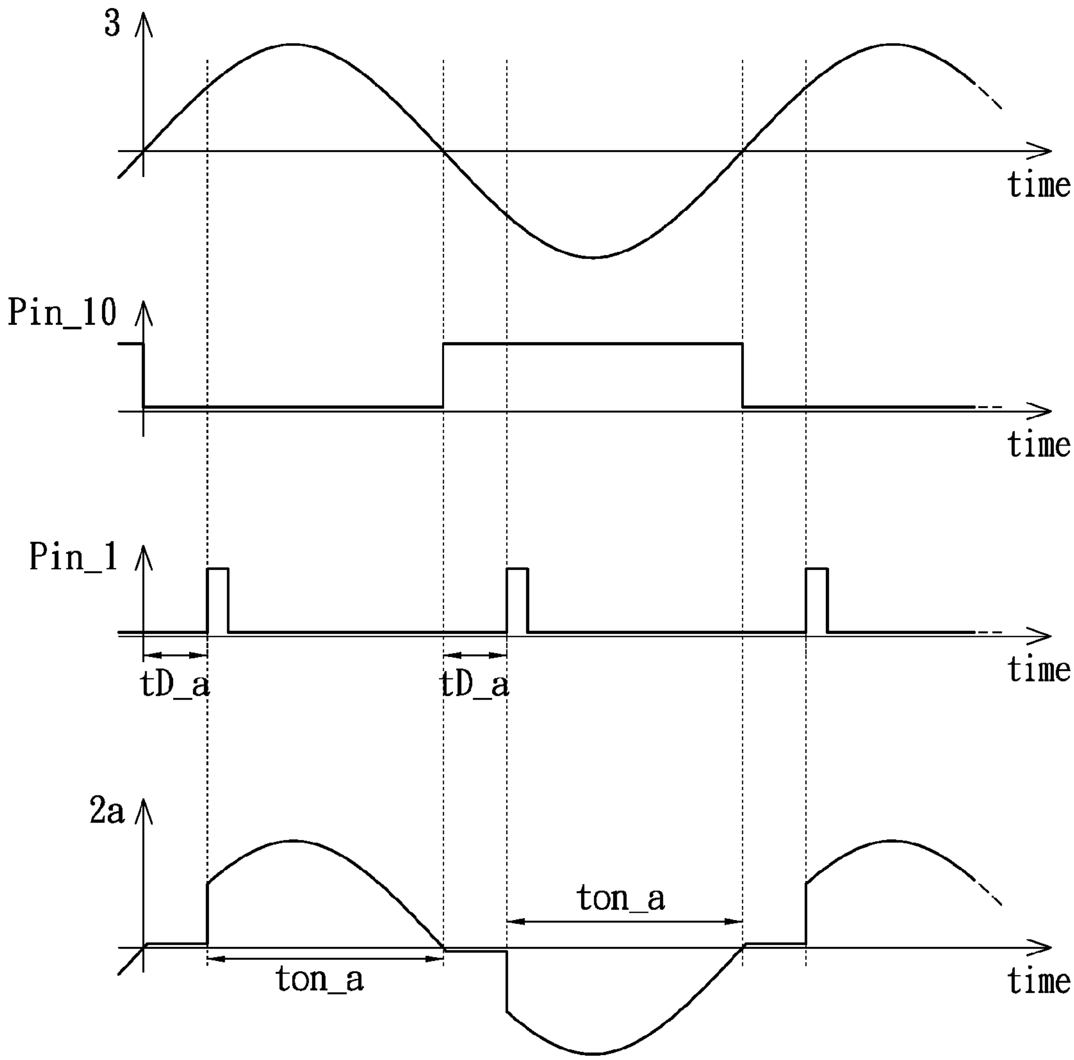

FIG. 6

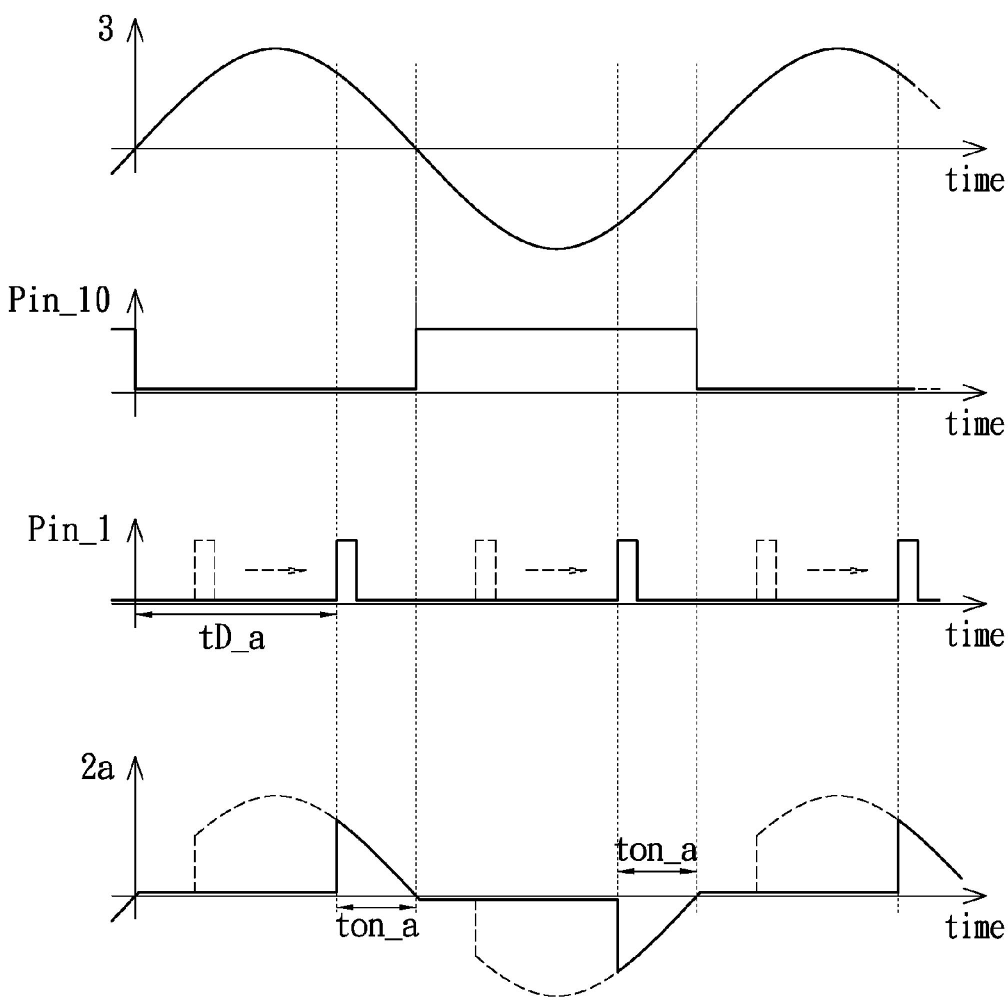

FIG. 7

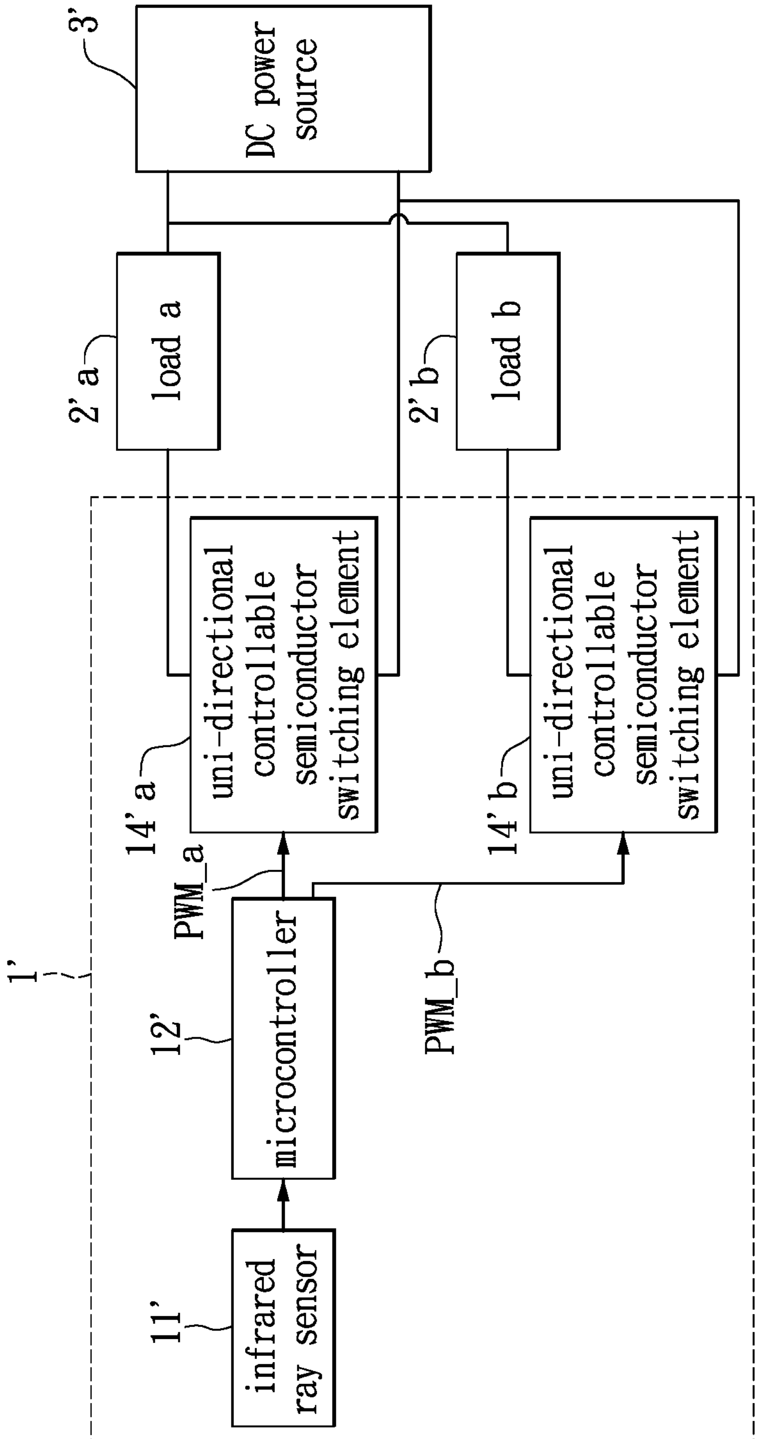
3'
DC power source
2'a
load a
2'b
load b
1'
14'a
uni-directional controllable semiconductor switching element
14'b
uni-directional controllable semiconductor switching element
PWM_a
PWM_b
12'
microcontroller
11'
infrared ray sensor

FIG. 8A

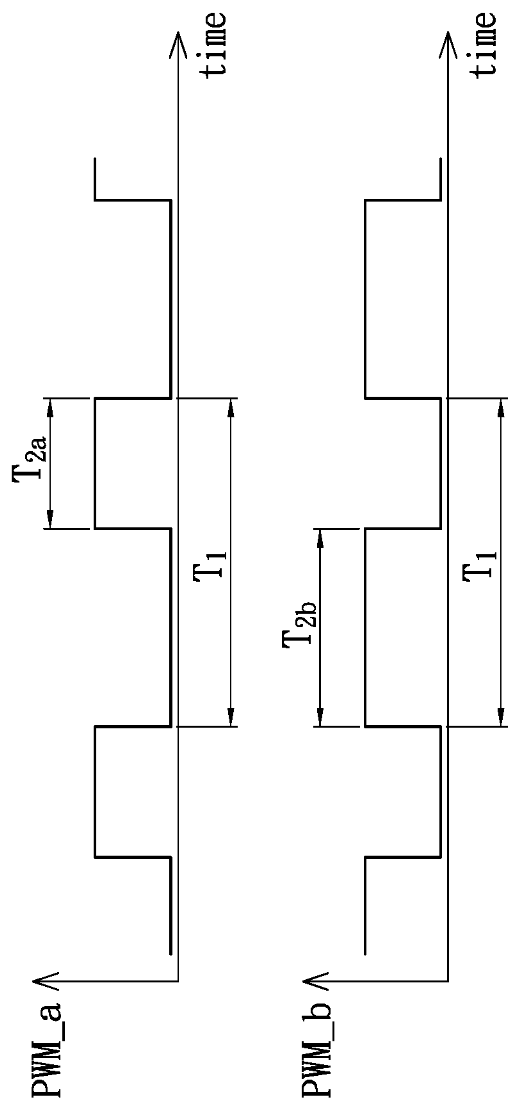

FIG. 8B

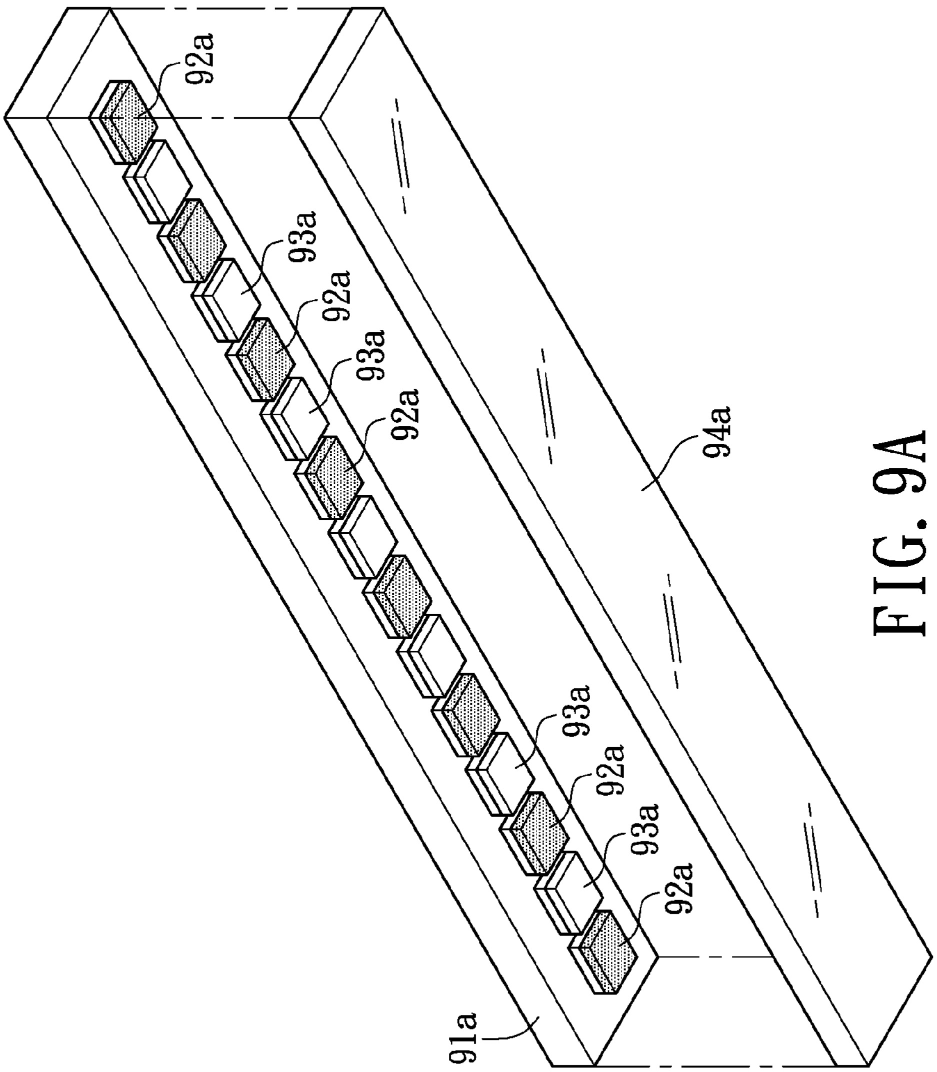

FIG. 9A

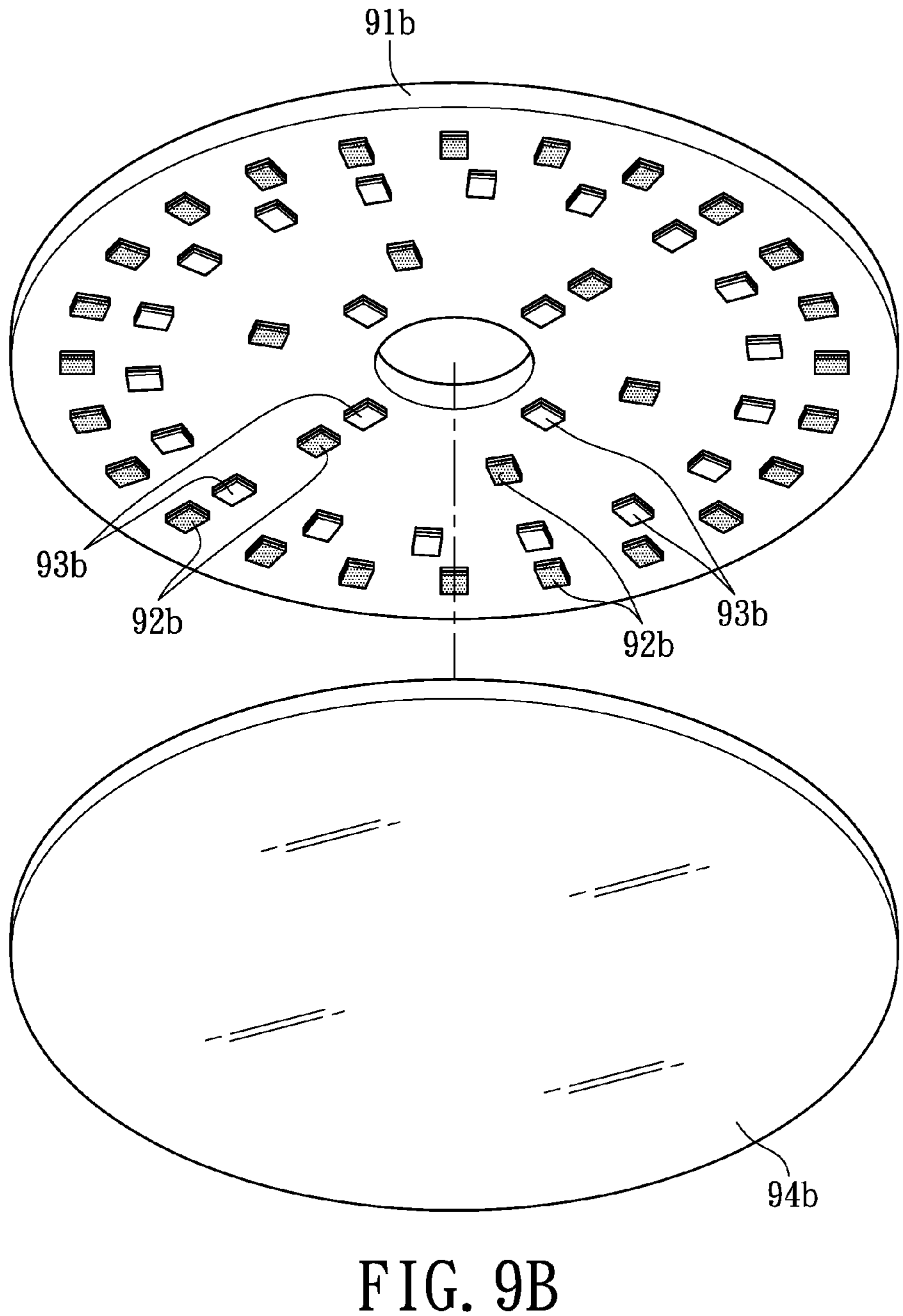

FIG. 9B

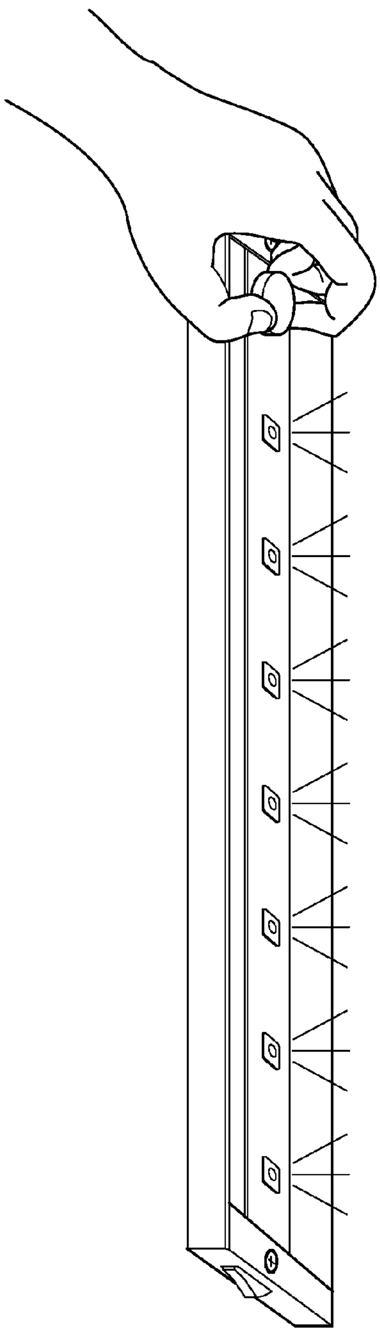

FIG. 10A
(PRIOR ART)

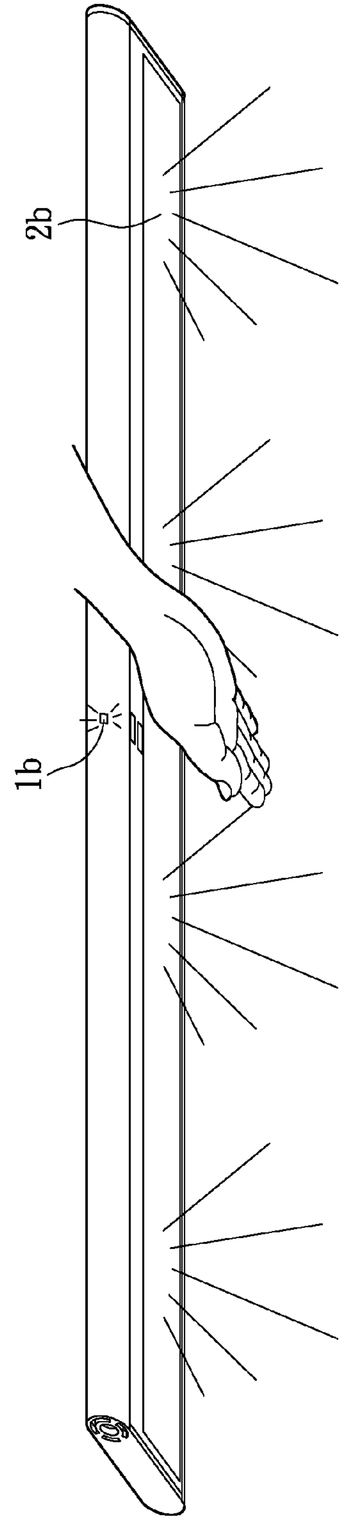

FIG. 10B

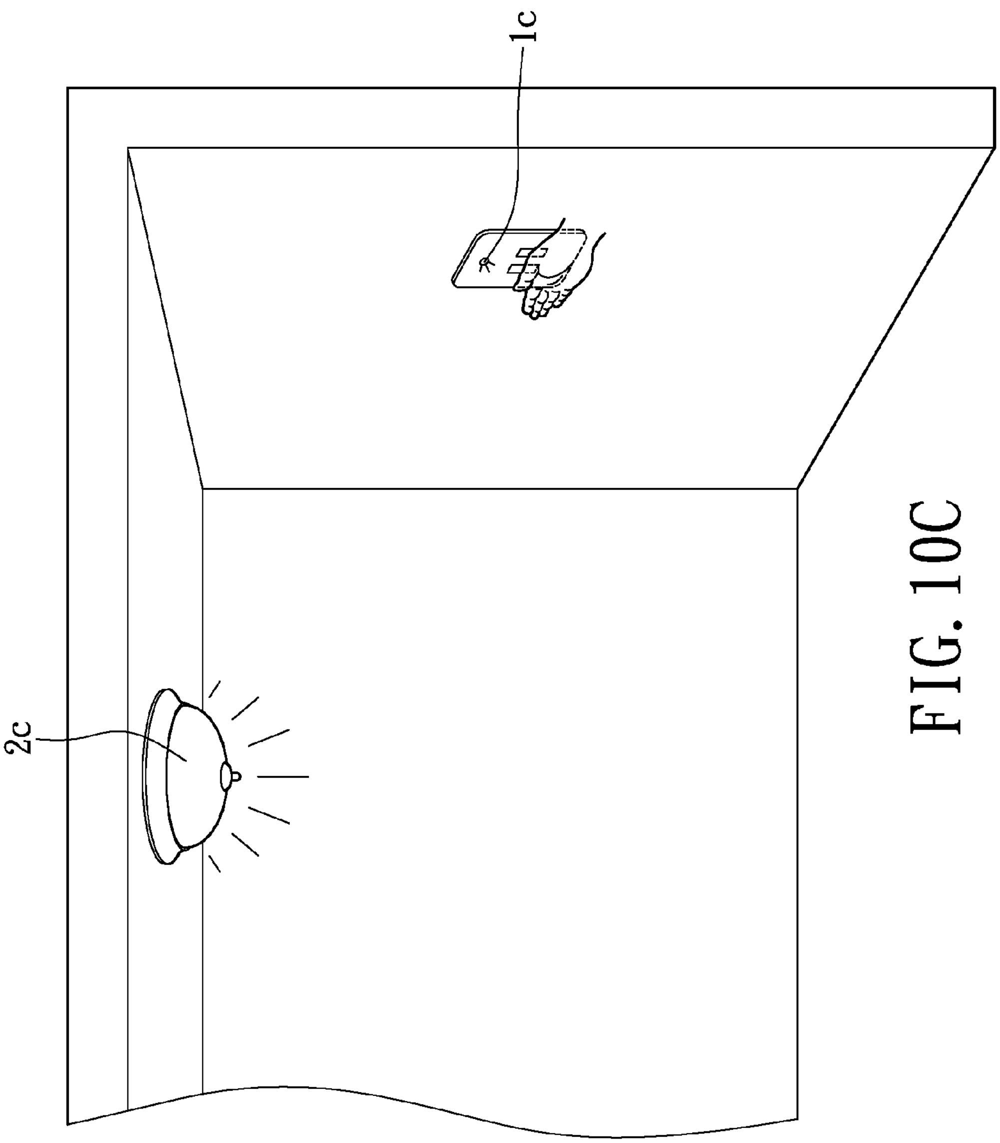

FIG. 10C

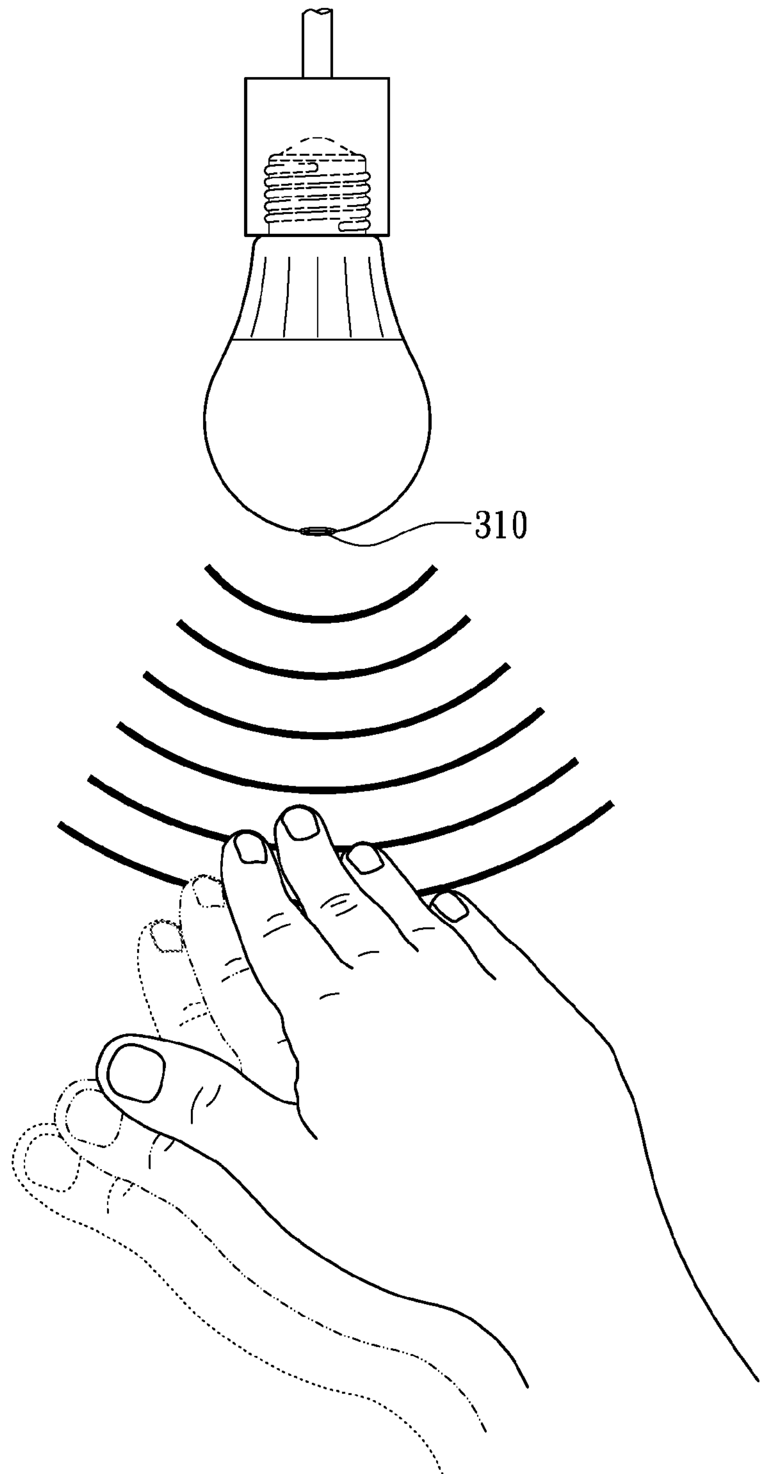

FIG. 10D

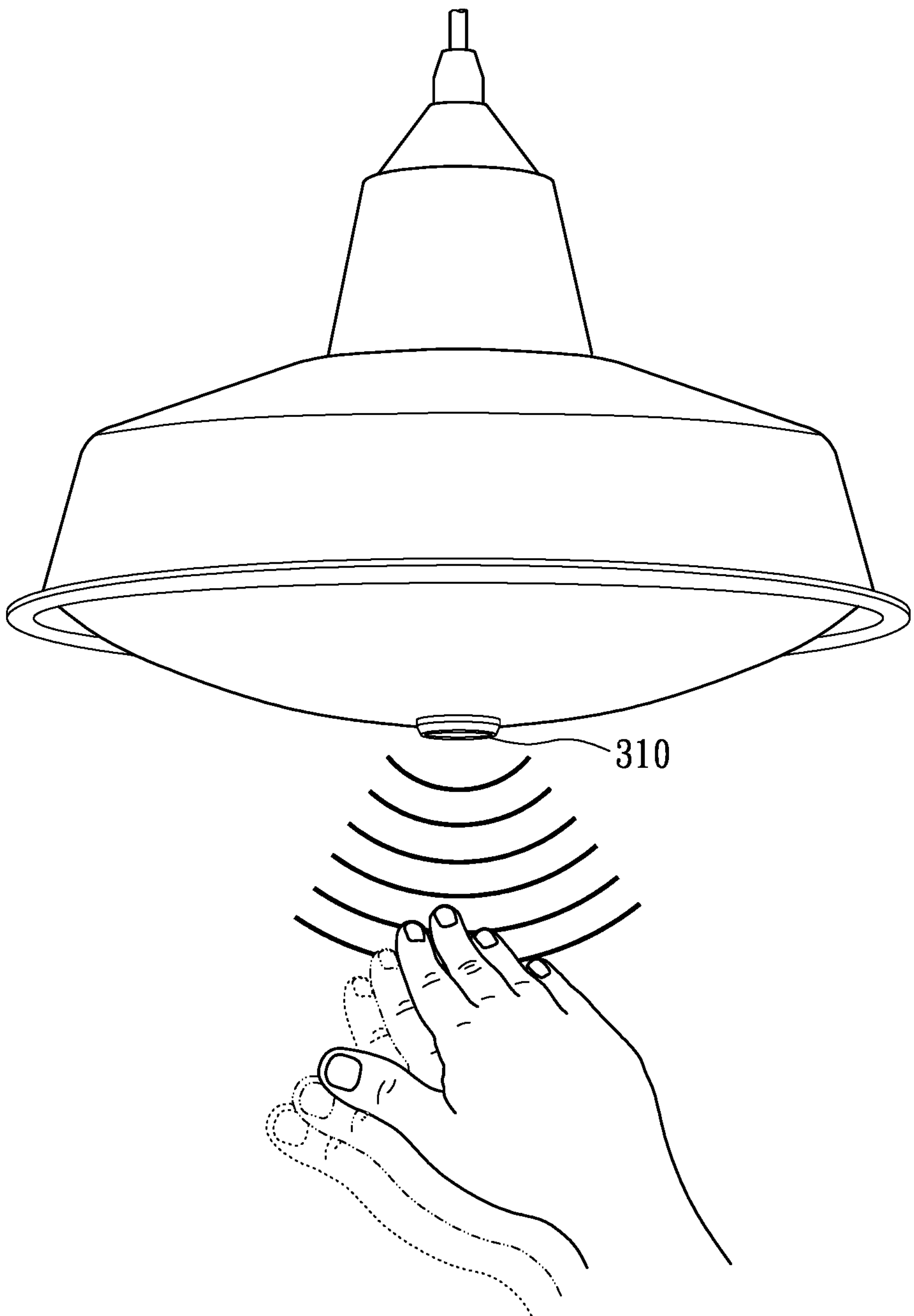

FIG. 10E

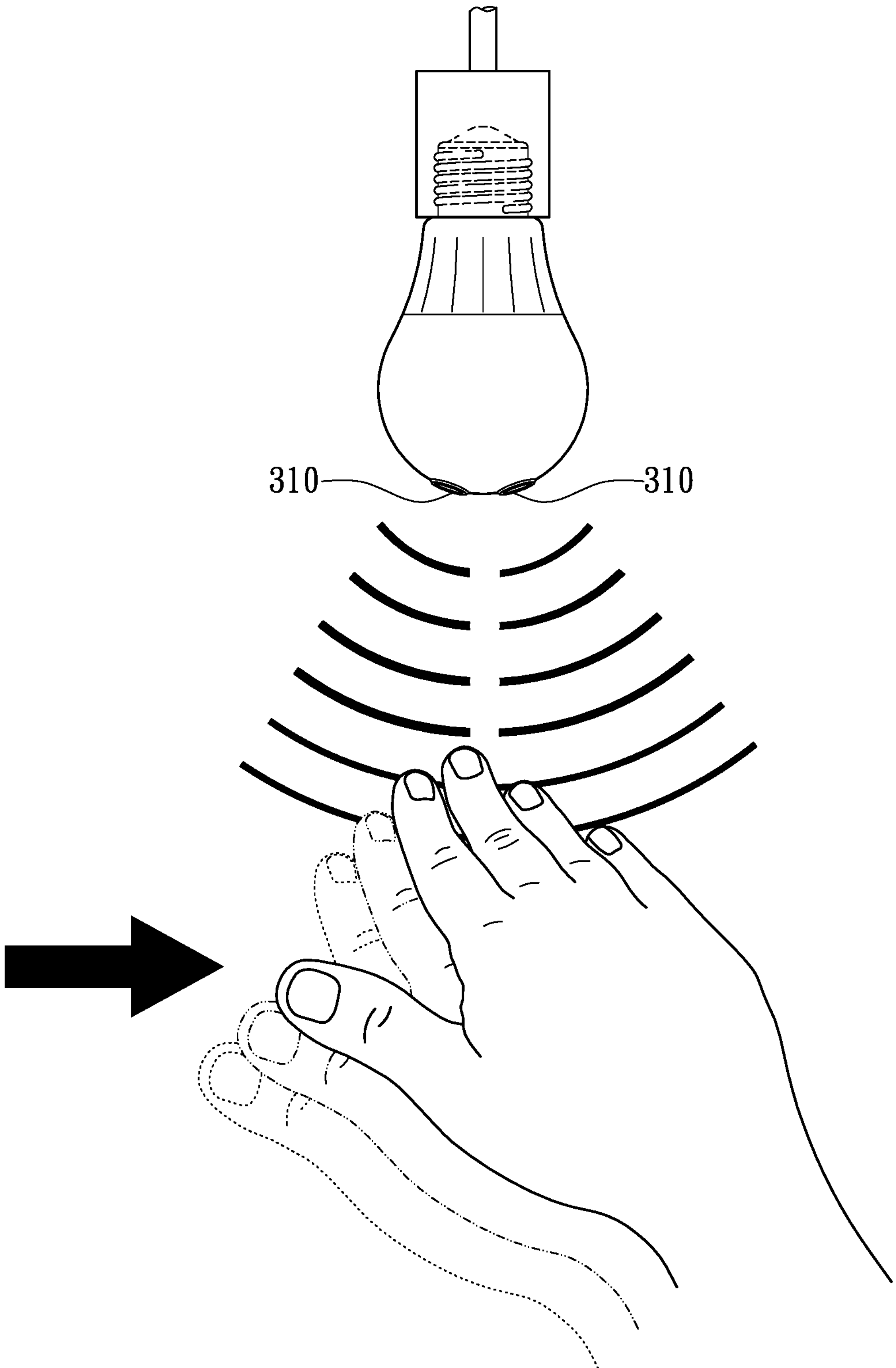

FIG. 11A

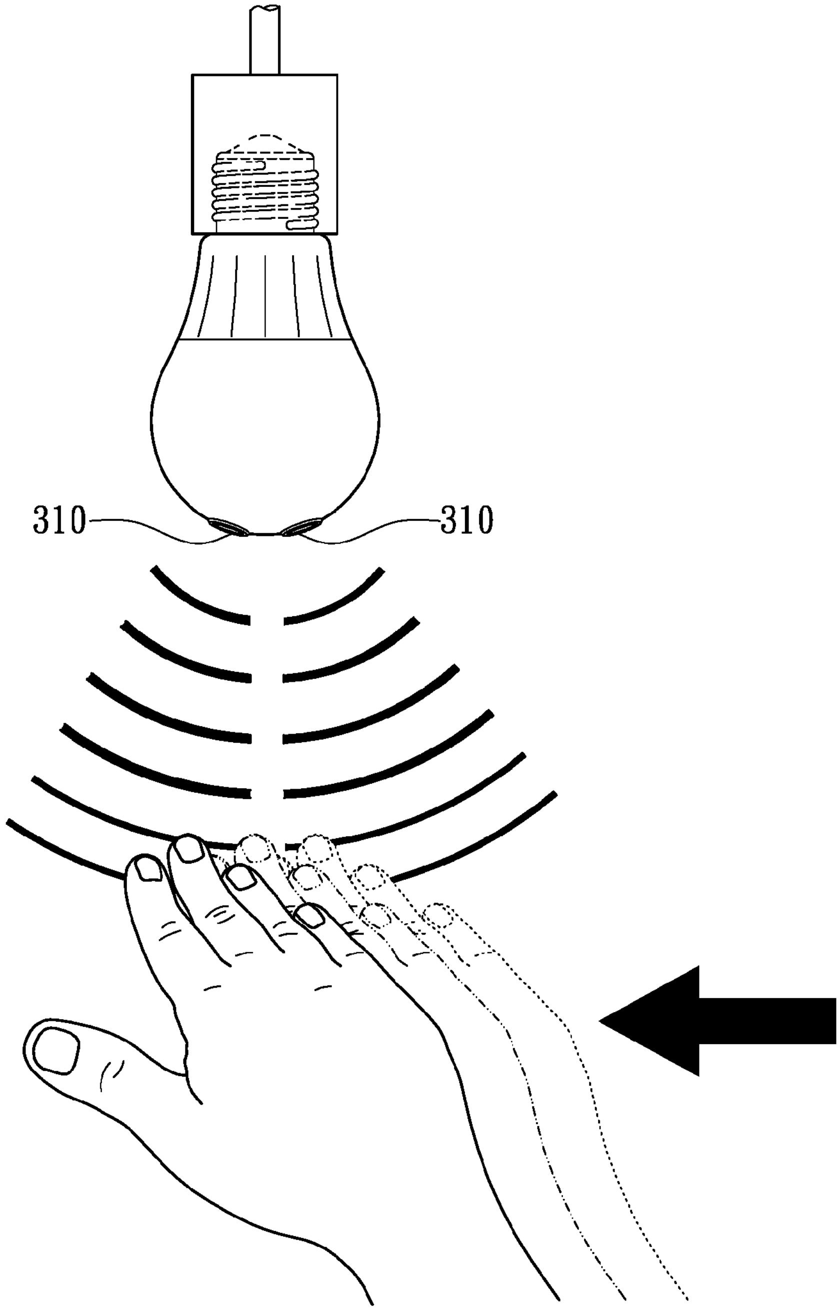

FIG. 11B

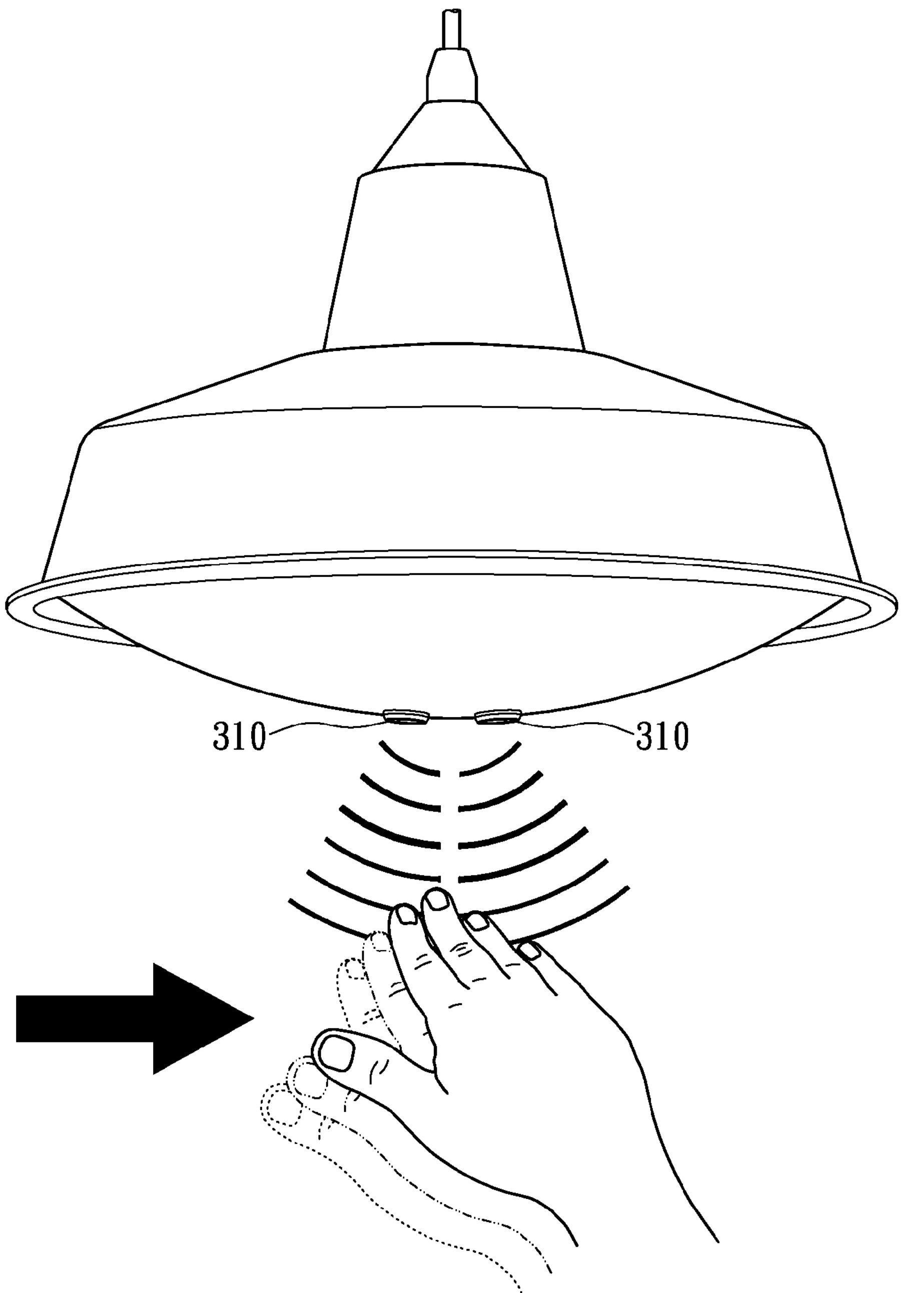

FIG. 11C

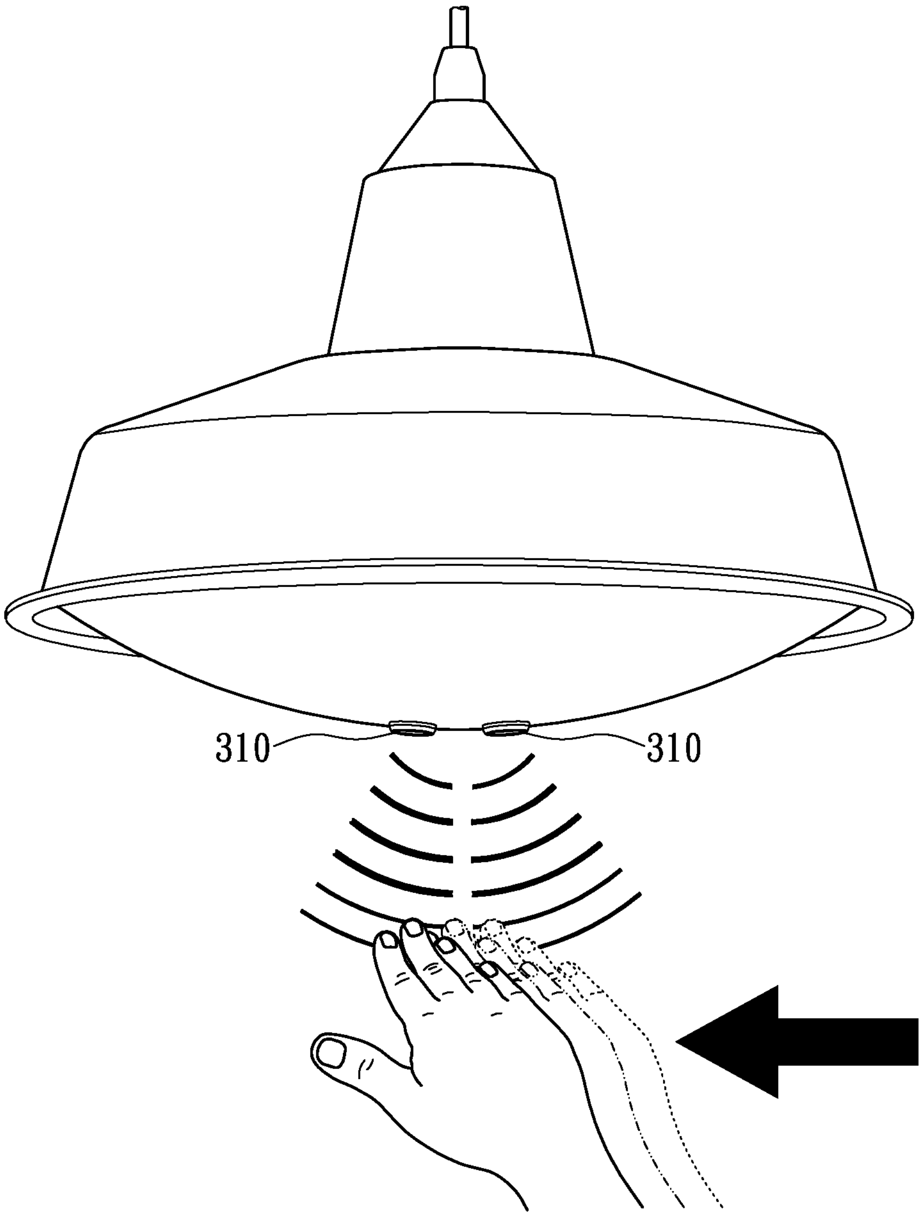

FIG. 11D

MICROCONTROLLER-BASED MULTIFUNCTIONAL ELECTRONIC SWITCH AND LIGHTING APPARATUS HAVING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

This Application is a continuation application of prior application Ser. No. 15/292,395 filed on Oct. 13, 2016, now U.S. Pat. No. 9,795,008. The application Ser. No. 15/292,395 is a continuation application of prior application Ser. No. 15/095,540 filed on Apr. 11, 2016, now U.S. Pat. No. 9,497,834. The application Ser. No. 15/095,540 is a continuation application of prior application Ser. No. 14/579,248 filed on Dec. 22, 2014, now U.S. Pat. No. 9,345,112 B2. The U.S. Pat. No. 9,345,112 B2 is a continuation-in-part of Non-provisional application Ser. No. 13/792,002 filed on Mar. 9, 2013, now U.S. Pat. No. 8,947,000 B2.

BACKGROUND

1. Technical Field

The present disclosure relates to a technology using a microcontroller with program codes designed to provide a user friendly solution for performing on/off switch control, diming control, and timer management for a lighting apparatus or an electrical appliance.

2. Description of Related Art

A mechanical-type electric switch is a manually operated electromechanical device. Its function is based on attaching or detaching two metal conductors to produce a short or open circuit, respectively. This mechanical-type switch is not suitable for installing in a space where has the concern of gas explosion, because an instantaneous surge current, produced by suddenly engaging or releasing the metallic contact of the switch, may generate electric sparks to ignite fire.

A controllable semiconductor switching element, such as a triac, has nearly zero voltage between two output-electrodes in conduction mode and nearly zero current through two output-electrodes in cut-off mode. Solid state electronic switch utilizing the above unique features of triac for circuit on/off switch control can avoid generating electric arc, since the main current pathway of the solid-state switch is not formed by engaging the two metal conductors. It becomes a much better choice than mechanical-type electric switch from the stand point of safety consideration.

Solid-state electronic switches are constructed with various methods to trigger controllable switching element, like triac or thyristor, into conduction or cutoff for desired electric power transmission. For example, U.S. Pat. No. 4,322,637 disclosed a technique using optical coupling element to control bi-directional thyristor or triac in conduction or off state; or another U.S. Pat. No. 6,285,140B1 disclosed a technique using microcontroller incorporated with zero-crossing-point detector to generate AC-synchronized time-delay pulse to control triac in on or cut-off state so as to transmit variable electric power to a light-emitting diode load.

Mostly a mechanical toggle or spring button of similar setup is usually applied on the electronic switch to facilitate manual on/off switch operation. The operation of electronic switch with mechanical toggle means an inevitable contact by hand which is not appropriate in working places such as kitchens or hospitals. To relieve concerns of contagion or contamination resulted through hand contacts, touchless switches are developed. For example, U.S. Pat. No. 5,637,863 disclosed a technique utilized infrared sensor to activate electronic switch to operate on/off switch control, and even dimming control presumably by modifying its circuit design.

In retrospect, the above mentioned prior arts have however still some drawbacks. For instance, U.S. Pat. No. 5,637,863 used a complicated infrared sensor construction and circuit design; or U.S. Pat. No. 6,285,140B1 did not resort to an efficient control of electric power transmission from power source to various electric impedances which is required in lighting apparatus.

SUMMARY

An exemplary embodiment of the present disclosure provides a microcontroller based electronic switch for detecting an external motion signal. The microcontroller based electronic switch comprises a first controllable switching element, a second controllable switching element, a detection device and a microcontroller. The first controllable switching element is electrically connected between a power source and a first lighting load for emitting light with a first color temperature. The second controllable switching element is electrically connected between the power source and a second lighting load for emitting light with a second color temperature. The detection device is for detecting an external motion signal played by a user and converting said external motion signal into a message carrying sensing signal. The microcontroller with program codes is written and designed to read and interpret the message carrying sensing signal generated by said detection device, wherein said microcontroller is electrically connected between said first controllable switching element and said detection device, said microcontroller is electrically connected between said second controllable switching element and said detection device. Said microcontroller controls a conduction state or cutoff state of said first controllable switching element and said second controllable switching element according to said message carrying sensing signal generated by said detection device. When the first controllable switching element and the second controllable switching element are in the conduction state, said microcontroller further controls electric power transmission levels from the power source to the first lighting load and the second lighting load according to specific format of said message carrying sensing signal received from said detection device.

In one exemplary embodiment, the detection device is an infrared ray sensor comprising a means for emitting infrared light to form a defined infrared ray detecting zone and a means for detecting infrared light reflected from an object moving into said infrared ray detecting zone. A circuitry responsively generates a message carrying sensing signal having a first voltage with a time length corresponding to the time interval the object entering and staying in said infrared ray detecting zone. When the object leaves the infrared ray detecting zone, the infrared ray sensor delivers a second voltage signal.

In one exemplary embodiment, the detection device is an electrostatic induction sensor comprising a copper sheet sensing unit with adequately designed shape and size to form an electrostatic detecting zone. A circuitry responsively generates a message carrying sensing signal having a first voltage with a time length corresponding to the time interval an inductive object enters and stays in said electrostatic

detecting zone. When said object leaves said electrostatic detecting zone, said electrostatic sensor delivers a second voltage signal.

In one exemplary embodiment, the detection device is a direct touch interface (such as a push button or a touch sensor) connecting with a pin of the microcontroller. When the user contacts the direct touch interface (for example, presses the push button) for a time interval, a first voltage signal is detected by the microcontroller which is a message carrying sensing signal having the first voltage with a time length corresponding to the time interval the touch interface being contacted. When the user leaves the direct touch interface (for example, releases the button), the direct touch interface delivers a second voltage signal.

An exemplary embodiment of the present disclosure provides a lighting apparatus comprising a first lighting load, a second lighting load, a diffuser and a microcontroller based electronic switch. The first lighting load is for emitting light with a first color temperature. The second lighting load is for emitting light with a second color temperature. The diffuser covers the first lighting load and the second lighting load. The microcontroller based electronic switch comprises a first controllable switching element, a second controllable switching element, a detection device and a microcontroller. The first controllable switching element is electrically connected between the first lighting load and a power source. The second controllable switching element is electrically connected between the second lighting load and the power source. The detection device is for detecting an external motion signal played by a user and converting said external motion signal into a message carrying sensing signal. The microcontroller with program codes is written and designed to read and interpret the message carrying sensing signal generated by said detection device, wherein said microcontroller is electrically connected between said first controllable switching element and said detection device, said microcontroller is electrically connected between said second controllable switching element and said detection device. Said microcontroller controls a conduction state or cutoff state of said first controllable switching element and said second controllable switching element according to said message carrying sensing signal generated by said detection device. When the first controllable switching element and second controllable switching element are in the conduction state, said microcontroller further controls electric power transmission levels from the power source to the first lighting load and the second lighting load according to specific format of said message carrying sensing signal received from said detection device. With the microcontroller based electronic switch to control the lighting power levels, the color temperature of the diffused light (also called the blended or mingled light) of the first lighting load and the second lighting load can be controlled.

In one exemplary embodiment, the detection device is an infrared ray sensor comprising a means for emitting infrared light to form a defined infrared ray detecting zone and a means for detecting infrared light reflected from an object moving into said infrared ray detecting zone. A circuitry responsively generates a message carrying sensing signal having a first voltage with a time length corresponding to the time interval the object entering and staying in said infrared ray detecting zone. When the object leaves the infrared ray detecting zone, the infrared ray sensor delivers a second voltage signal.

In one exemplary embodiment, the detection device is an electrostatic induction sensor comprising a copper sheet sensing unit with adequately designed shape and size to form an electrostatic detecting zone. A circuitry responsively generates a message carrying sensing signal having a first voltage with a time length corresponding to the time interval an inductive object enters and stays in said electrostatic detecting zone. When said object leaves said electrostatic detecting zone, said electrostatic sensor delivers a second voltage signal.

In one exemplary embodiment, the detection device is a direct touch interface (such as a push button or a touch sensor) connecting with a pin of the microcontroller. When the user contacts the direct touch interface (for example, presses the push button) for a time interval, a first voltage signal is detected by the microcontroller which is a message carrying sensing signal having the first voltage with a time length corresponding to the time interval the touch interface being contacted. When the user leaves the direct touch interface (for example, releases the button), the direct touch interface delivers a second voltage signal.

To sum up, the present disclosure is characteristic in, a contactless interface between the user and the multifunctional electronic switch is created to implement at least two operation modes of the electronic switch by using software codes written in OTPROM (one-time programmable read only memory) of microcontroller to analyze the message carrying sensing signals.

In order to further understand the techniques, means and effects of the present disclosure, the following detailed descriptions and appended drawings are hereby referred, such that, through which, the purposes, features and aspects of the present disclosure can be thoroughly and concretely appreciated; however, the appended drawings are merely provided for reference and illustration, without any intention to be used for limiting the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the present disclosure, and are incorporated in and constitute a part of this specification. The drawings illustrate exemplary embodiments of the present disclosure and, together with the description, serve to explain the principles of the present disclosure.

FIG. **1** is a block diagram of a microcontroller based electronic switch using an infrared ray sensor as a detection device applied for two AC lighting loads with different color temperatures powered by an AC power source according to an exemplary embodiment of the present disclosure.

FIG. **2** is a circuit diagram of a microcontroller based electronic switch using an infrared ray sensor applied for two AC lighting loads with different color temperatures powered by an AC power source according to an exemplary embodiment of the present disclosure.

FIG. **3**A is a schematic diagram showing a practical operation of an infrared ray sensor associated with a microcontroller based electronic switch according to an exemplary embodiment of the present disclosure.

FIG. **3**B is a waveform diagram showing a low voltage sensing signal according to an exemplary embodiment of the present disclosure.

FIG. **4** is a flow chart of a program executed in a microcontroller based electronic switch according to an exemplary embodiment of the present disclosure.

FIG. **5** is a voltage waveform diagram of a microcontroller based electronic switch when the electronic switch operating in the on/off switch control mode is in cut-off state according to an exemplary embodiment of the present disclosure.

FIG. **6** is a voltage waveform diagram of a microcontroller based electronic switch when the electronic switch operating in the on/off switch control mode is in conduction state according to an exemplary embodiment of the present disclosure.

FIG. **7** is a voltage waveform diagram of a microcontroller based electronic switch operating in the dimming control mode according to an exemplary embodiment of the present disclosure.

FIG. **8**A is a block diagram of a microcontroller based electronic switch for a DC power source according to an exemplary embodiment of the present disclosure.

FIG. **8**B is a voltage waveform diagram of the pulse width modulation voltage signals associated with FIG. **8**A according to an exemplary embodiment of the present disclosure.

FIG. **9**A is an application diagram of an exemplary embodiment of the present disclosure for a lighting apparatus.

FIG. **9**B is an application diagram of an exemplary embodiment of the present disclosure for a lighting apparatus.

FIG. **10**A is an application diagram of a traditional popular piece of under cabinet light with LED as light source.

FIG. **10**B is an application diagram of an exemplary embodiment of the present disclosure for a LED under cabinet light featured with a touch-less interface between the user and the under cabinet light.

FIG. **10**C is an application diagram of an exemplary embodiment of the present disclosure for a wall switch construction electrically connected to a ceiling light for the performance of three working modes.

FIG. **10**D is another application diagram of an exemplary embodiment of the present disclosure for a lighting apparatus with a diffuser of hollow body accommodating the lighting loads and the microcontroller based electronic switch.

FIG. **10**E is another application diagram of an exemplary embodiment of the present disclosure for a lighting apparatus with a diffuser of hollow body accommodating the lighting loads and the microcontroller based electronic switch.

FIG. **11**A is another application diagram of an exemplary embodiment of the present disclosure for the direction of motion path detected by an infrared ray sensor.

FIG. **11**B is another application diagram of an exemplary embodiment of the present disclosure for the direction of motion path detected by an infrared ray sensor.

FIG. **11**C is another application diagram of an exemplary embodiment of the present disclosure for the direction of motion path detected by an infrared ray sensor.

FIG. **11**D is another application diagram of an exemplary embodiment of the present disclosure for the direction of motion path detected by an infrared ray sensor.

DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

Reference will now be made in detail to the exemplary embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or like parts.

Referring to FIG. **1**, FIG. **1** is a block diagram of a microcontroller based electronic switch using an infrared ray sensor as a detection device applied for two AC lighting loads with different color temperatures powered by an AC

power source according to an exemplary embodiment of the present disclosure. A microcontroller based electronic switch **1** is connected in series to an AC power source **3**, and is further connected to a first lighting load **2***a* (also indicated by "load a" shown in FIG. **1**) and a second lighting load **2***b* (also indicated by "load b" shown in FIG. **1**), so as to control AC power delivered to the first lighting load **2***a* and the second lighting load **2***b*. The microcontroller based electronic switch **1** comprises at least an infrared ray sensor **11**, a microcontroller **12**, a zero-crossing-point detector **13**, and two bi-directional controllable semiconductor switching elements **14***a*, **14***b*. The bi-directional controllable semiconductor switching element **14***a* is a first controllable switching element. The bi-directional controllable semiconductor switching element **14***b* is a second controllable switching element. The infrared ray sensor **11** is connected to one pin of microcontroller **12** to transmit a low voltage sensing signal to the microcontroller **12**, wherein the low voltage sensing signal represents a message carrying sensing signal of the infrared ray sensor **11**. The zero-crossing-point detector **13** is connected to another pin of microcontroller **12** and is also electrically coupled to the AC power source **3** to produce AC power synchronized signals which are fed to the microcontroller **12**. The microcontroller **12** through its one designated pin is electrically connected to the control electrode of the bi-directional controllable semiconductor switching element **14***a* so as using appropriate conduction phase (characterized by tD_a) to control the electrical conduction state of the bi-directional controllable semiconductor switching element **14***a*. Also, the microcontroller **12** through its another one designated pin is electrically connected to the control electrode of the bi-directional controllable semiconductor switching element **14***b* so as using appropriate conduction phase (characterized by tD_b) to control the electrical conduction state of the bi-directional controllable semiconductor switching element **14***b*.

The first lighting load **2***a* is for emitting light with low color temperature (first color temperature), and the second lighting load **2***b* is for emitting light with high color temperature (second color temperature). When the bi-directional controllable semiconductor switching elements **14***a*, **14***b* are in the conduction state, said microcontroller **12** further controls electric power transmission levels from the AC power source **3** to the first lighting load **2***a* and the second lighting load **2***b* according to the signal format of the message carrying sensing signal received from the infrared ray sensor **11**. In this embodiment, the electric power transmission level for the first lighting load **2***a* can range from X-watt to Y-watt, and reversely the electric power transmission level for the second lighting load **2***b* can range from Y-watt to X-watt, where X is a minimum electric power transmitted to the first lighting load or the second lighting load, Y is a minimum electric power transmitted to the first lighting load or the lighting load, and X+Y is a constant value, but the present disclosure is not so restricted. An apparent color temperature generated by blending the lights emitted from the two lighting loads **2***a*,**2***b* may be controlled by the power levels X and Y according to

$$CT_{app}=CT_{2a}\cdot X/(X+Y)+CT_{2b}\cdot Y/(X+Y),$$

where CT_{app} is said apparent color temperature, CT_{2a} and CT_{2b} are respectively the color temperatures of the first and the second lighting load **2***a*, **2***b*.

For example, X-watt can be three watts and Y-watt can be nine watts, such that the power of the first lighting load **2***a* ranges from three watts to nine watts, and the power of the second lighting load **2***b* ranges from nine watts to three

watts, wherein the total power of the first lighting load **2***a* and the second lighting load **2***b* can be fixed to twelve watts. When the color temperatures of the first lighting load **2***a* and the second lighting load **2***b* are respectively 3000K (CT_{2a}) and 5700K (CT_{2b}), the apparent color temperature (CT_{app}) of the blended or diffused light of the first lighting load **2***a* and the second lighting load **2***b* can range nearly from 3700K (nine watts of the first lighting load **2***a* and three watts of the second lighting load **2***b*) to 5000K (three watts of the first lighting load **2***a* and nine watts of the second lighting load **2***b*) depending on the electric power transmission levels fed to the first lighting load **2***a* and the second lighting load **2***b* controlled by the microcontroller **12**.

In another example, X-watt can be zero watts and Y-watt can be twelve watts, such that the power of the first lighting load **2***a* ranges from zero watts to twelve watts, and the power of the second lighting load **2***b* ranges from twelve watts to zero watts, wherein X+Y watt can be fixed to twelve watts. When the color temperatures of the first lighting load **2***a* and the second lighting load **2***b* are respectively 3000K and 5700K, the apparent color temperature of the diffused light of the first lighting load **2***a* and the second lighting load **2***b* can range from 3000K (twelve watts of the first lighting load **2***a* and no power of the second lighting load **2***b*) to 5700K (twelve watts of the second lighting load **2***b* and no power of the first lighting load **2***a*) depending on the electric power transmission levels fed to the first lighting load **2***a* and the second lighting load **2***b*. Thus, a desired color temperature may be generated by controlling the power levels of the first lighting load **2***a* and the second lighting load **2***b* to create proper color blending effect under a fixed total lighting power level with this type of microcontroller based electronic switch.

In still another embodiment, the electric power transmission level for the first lighting load **2***a* can range from X-watt to Y-watt, and the electric power transmission level for the second lighting load **2***b* can range from Z-watt to W-watt, wherein X, Y, Z and W can be referred to different power levels. However, the present disclosure does not restrict the variation ranges of the power levels of the two loads **2***a*, **2***b*.

The infrared ray sensor **11** detects object motions coming from the user and converts the detected result into message carrying low voltage sensing signals readable to the microcontroller **12**. The microcontroller **12** decodes the low voltage sensing signals (message carrying low voltage sensing signals) according to the program designed and written in its OTPROM (one-time programmable read only memory) memory. The microcontroller **12** is with program codes written and designed to read and interpret the message carrying sensing signal generated by the infrared ray sensor **11**. The infrared ray sensor **11** is an exemplary embodiment for a detection device to detect the external motion signal played by the user and convert the external motion signal into a message carrying sensing signal. The microcontroller **12** recognizes the working mode that the user has chosen and proceeds to execute the corresponding loop of subroutine for performing the selected working mode. In view of implementing versatile controls of color temperature and illumination level of a lighting apparatus, at least two working modes are provided and defined in the software codes with corresponding loops of subroutine for execution.

One working mode is on/off switch control mode. In this working mode, according to the low voltage sensing signal from the infrared ray sensor **11**, the microcontroller **12** operates the bi-directional controllable semiconductor switching element **14** in conduction state or cut-off state alternatively. More specifically, in this working mode, together with the zero-crossing-point detector **13**, the microcontroller **12** generates phase delay voltage pulses synchronized with the AC power source **3** in each AC-half cycle to trigger the bi-directional controllable semiconductor switching elements **14***a*, **14***b* to be in proper conduction states to respectively transmit X-watt and Y-watt electric power to the first lighting load **2***a* and the second lighting load **2***b*, such that a fixed amount of total electric power (X+Y watts) is sent to the two lighting loads **2***a*, **2***b*; or the microcontroller **12** generates a zero voltage to set the bi-directional controllable semiconductor switching elements **14***a*, **14***b* to be in cut-off state, and thereby ceases to transmit the fixed electric power to the two lighting loads **2***a*, **2***b*.

Another working mode is switching between low color temperature and high color temperature. When the first switching element is in a full conduction state and the second switching element is in a full cutoff state, the light consequently demonstrates the low color temperature of illumination characteristic. When the first switching element is in the full cutoff state and the second switching element is in the full conduction state, the lighting apparatus consequently demonstrates the high color temperature of illumination characteristic.

Still another working mode is color temperature tuning mode about controlling different levels of electric power transmission to the two lighting loads **2***a*, **2***b* by controlling the conduction rate of the bi-directional controllable semiconductor switching elements **14***a* and **14***b*. Using the synchronized signals produced by the zero-crossing-point detector **13** as a reference, the microcontroller **12** generates phase delay voltage pulses synchronized with the AC power source **3** in each AC half-cycle to trigger the conduction of the bi-directional controllable semiconductor switching elements **14** to respectively transmit X-watt and Y-watt electric power to the first lighting load **2***a* and the second lighting load **2***b*. Responding to the low voltage sensing signals of specific format from the infrared ray sensor **11**, the microcontroller **12** execute the corresponding loop of subroutine for performing the color temperature tuning mode, such that the phase delays of the triggering pulses are continuously changed during each half cycle period of the AC power source **3**, to render the conduction rate of the bi-directional controllable semiconductor switching elements **14***a* gradually increasing and, at the same time, the conduction rate of the bi-directional controllable semiconductor switching elements **14***b* gradually decreasing, or vice versa. Consequently, the power level X of the lighting loads **2***a* is gradually increasing and the power level Y of the lighting loads **2***b* is gradually decreasing, or vice versa. The color temperature of the blended or diffused light of the two lighting load **2***a*, **2***b* may thus be adjusted in the color temperature tuning mode through controlling the conduction rate of the switching elements **14***a*, **14***b* to change the power levels of the two lighting loads **2***a*, **2***b*. At the end of the color temperature tuning mode, a desired apparent color temperature diffused from the two lighting loads **2***a*, **2***b* can be set and managed by the message carrying sensing signal from the infrared ray sensor **11** which is generated according to the user's intention.

For the color temperature tuning mode, additional submodes can be performed in detail. When the detection device generates the first voltage sensing signal, said microcontroller manages to output the control signal to the first controllable switching element and the second controllable switching element to alternately perform one of programmed combinations of conduction states between the first controllable switching element and the second control-

lable switching element, wherein the combinations include at least three combination modes; wherein the first combination mode is where the first controllable switching element is in a complete conduction state while the second controllable switching element is in a cutoff state with the lighting apparatus performing the low color temperature, wherein the second combination mode is where the first controllable switching element is in a cutoff state while the second controllable switching element is in a complete conduction state with the lighting apparatus performing the high color temperature, wherein the third combination mode is where both the first controllable switching element and the second controllable switching element are in cutoff state with the lighting apparatus being turned off.

Referring to FIG. **1** and FIG. **2**, FIG. **2** is a circuit diagram of a microcontroller based electronic switch applied for an AC power source according to an exemplary embodiment of the present disclosure.

As FIG. **2** shows, the microcontroller based electronic switch **1** comprises an infrared ray sensor **11**, a microcontroller **12**, a zero-crossing-point detector **13**, and two bi-directional controllable semiconductor switching elements **14***a*, **14***b*. The microcontroller based electronic switch **1** is connected respectively through the bi-directional controllable semiconductor switching elements **14***a*, **14***b* with the first lighting load **2***a* and the second lighting load **2***b*, both have different color temperatures, and then connected to the AC power source **3** in a serial fashion. A DC voltage VDD for the circuit system is derived by conventional voltage reduction and rectification from the AC power **3**. The infrared ray sensor **11** is composed of a transmitting circuit **110** and a receiving circuit **112**, wherein the message carrying sensing signal is sent out by a transistor stage M**2**. The drain of the transistor M**2** is connected to a pin pin_**3** of the microcontroller **12** to deliver the message carrying sensing signals to the microcontroller **12**.

The zero-crossing-point detector **13** is composed of a transistor Q**1** and a diode D**3**. The collector of the transistor Q**1** is connected to a pin pin_**10** of the microcontroller **12**, the base of the transistor Q**1** is connected to a conducting wire of the AC power source **3** through the diode D**3** and a resistor R**3**. In the positive half-cycle for AC power source **3**, the transistor Q**1** is saturated conducting, and the voltage at the collector of the transistor Q**1** is close to zero. In the negative half-cycle for AC power source **3**, the transistor Q**1** is cut-off, and the voltage at the collector of the transistor Q**1** is a high voltage of VDD. Corresponding to the sine wave of the AC power source **3**, the zero-crossing-point detector **13** generates therefore signals of square wave alternatively with a low voltage and a high voltage through the collector of the transistor Q**1**. The square wave is synchronized with the AC power source **3** and sent to a pin pin_**10** of the microcontroller **12** for the purpose of controlling conduction phase, and the details thereof are described later. In practice, the bi-directional controllable semiconductor switching element **14***a* can be a triac T**1***a*, the pin pin_**1** of the microcontroller **12** is connected to the gate of the triac T**1***a* to control the conduction or cut-off state of the triac T**1***a*, or to control the conduction rate of the triac T**1***a*. Also, the bi-directional controllable semiconductor switching element **14***b* can be a triac T**1***b*, the pin pin_**2** of the microcontroller **12** is connected to the gate of the triac T**1***b* to control the conduction or cut-off state of the triac T**1***b*, or to control the conduction rate of the triac T**1***b*. Thus, the first lighting load **2***a* and the second lighting load **2***b* are respectively driven by triac T**1***a* and triac T**1***b* with phase delay pulses characterized by time delays tD_a and tD_b with respect to the zero crossing point of AC power voltage in each AC half-cycle to respectively display X-watt (or Y-watt) lighting from the first lighting load **2***a* and Y-watt (or X-watt) power lighting from the second lighting load **2***b* controlled by infrared ray sensor **11**. Thus, the color temperature of the diffused light of the two lighting load **2***a*, **2***b* may be adjusted by properly selecting tD_a and tD_b, such that the summation of tD_a and tD_b is a constant, and the total lighting power of the first lighting load **2***a* (X) and the second lighting load **2***b* (Y), X+Y, is a fixed value.

Still referring to FIG. **2**, the infrared ray sensor **11** comprises a transmitting circuit and a receiving circuit. In the transmitting circuit, an infrared light-emitting diode IR_LED is connected to the drain of the transistor M**1** in a serial fashion, and the gate of the transistor M**1** is connected to an output of the timer **110**. In practice, the timer **110** can be a 555 timer IC. The 555 timer IC generates a square-wave with a frequency of about 3 kHz to modulate the drain current of the transistor M**1**, such that the infrared light-emitting diode IR_LED provides an infrared light signal with a square wave form which is severed as the light source of the infrared ray sensor.

The receiving circuit is an infrared light detection circuit and comprises a photosensitive diode PD, two serially connected amplifiers **112**, **114**, and a transistor M**2**. The drain of the transistor M**2** is connected to a pin pin_**3** of the microcontroller **12**. In practice, the amplifiers **112** and **114** can be LM324 operational amplifier. The combination of the amplifier **114** and resistors R**7** through R**10** is a Schmitt trigger circuit having a threshold voltage, and the threshold voltage is produced by the voltage divider composed by resistors R**8** and R**9**. The Schmitt trigger circuit makes possible a high discrimination of a true detection to a false one.

The photosensitive diode PD is used to receive the infrared light signal from the transmitting circuit. If the output voltage of the amplifier **112** exceeds the threshold voltage, the amplifier **114** produces a high voltage applied to the gate of the transistor M**2**, such that the transistor M**2** is turned on. Therefore, the drain of the transistor M**2** provides a low voltage sensing signal which is close to zero voltage, and the time length of the low voltage sensing signal is related to the time period the infrared ray is detected.

In addition, if the photosensitive diode PD does not receive the infrared light signal, the output voltage of the amplifier **112** is lower than the threshold voltage, and then the amplifier **114** provides a low voltage to the gate of the transistor M**2**, such that the transistor M**2** is turned off. Therefore, the drain of the transistor M**2** provides a high voltage of VDD. In other words, the pin pin_**3** of the microcontroller **12** receives either a low voltage sensing signal or a high voltage depending on whether the infrared ray sensor **11** detects the infrared light or not, wherein the time length of the low voltage sensing signal is about the time period within which the infrared light is detected.

In other words, the infrared ray sensor **11** generates a sensing signal which is characterized by a low voltage within a time length. The sensing signal with a specific time length of low voltage can be considered as a sensing signal format which carries message to make the microcontroller **12** to operate in one of at least two working modes accordingly, wherein one working mode is on/off switch control mode and the another one is color temperature tuning mode to control the conduction rate of the bi-directional controllable semiconductor switching elements **14***a* and **14***b*. Further, still another mode is dimming control mode. The color temperature tuning mode can give a color temperature

tuning cycle to change the color temperature of the blended light, wherein the total power of the blended light is unchanged (X+Y watts is unchanged during the cycle). The dimming control mode provides dimming cycles to set the total power of the blended light (X+Y watts is changed during the cycle), wherein the color temperature of the blended light is unchanged during the dimming cycle.

Referring to FIG. **2**, FIG. **3**A and FIG. **3**B, FIG. **3**A is a schematic diagram showing a practical operation of an infrared ray sensor associated with a microcontroller based electronic switch according to an exemplary embodiment of the present disclosure, and FIG. **3**B is a waveform diagram showing a low voltage sensing signal according to an exemplary embodiment of the present disclosure. In FIG. **3**A, the infrared light-emitting diode IR_LED is parallel arranged to the photosensitive diode PD without accurate alignment. When an object, here is a human hand, moves in front of the infrared light-emitting diode IR_LED, the infrared light emitted from the infrared light-emitting diode IR_LED scatters from the object surface onto the photo sensing surface of the photosensitive diode PD.

FIG. **3**B shows a waveform of the low voltage sensing signal provided from the infrared ray sensor **11**. If the photosensitive diode PD does not receive the infrared light scattered from the target object surface, or the intensity of the infrared light received by the photosensitive diode PD is insufficient, the drain of the transistor M2 provides a high voltage H of VDD. Within an appropriate distance, the photosensitive diode PD receives the infrared light scattered from the object surface, and the intensity of the received infrared light is enough to cause the output voltage of the amplifier **112** exceeding the threshold voltage, the amplifier **114** produces a high voltage, such that the transistor M2 is turned on, and the drain of the transistor M2 provides a signal with a low voltage L of about zero volt. In other words, when the infrared ray sensor **11** detects an object, most commonly user's hand, purposefully entering the infrared ray detecting zone, the infrared ray sensor **11** generates a low voltage sensing signal, by contrast when an object is not within the infrared ray detecting zone, the infrared ray sensor **11** generates a high voltage. In brief, the infrared ray sensor **11** comprises a means for emitting infrared light to form the defined infrared ray detecting zone, and a means for detecting infrared light reflected from the object moving into the infrared ray detecting zone.

The appropriate distance or the infrared ray detecting zone is defined as an effective sensing range or area of the infrared ray sensor **11**. In FIG. **3**B, the time length Ts of the low voltage L is approximately equal to the time period that an object stays within the infrared ray detecting zone, wherein the time period is about a few tenths through a few seconds. When the object leaves the infrared ray detecting zone, the signal delivered from the infrared ray sensor **11** changes from a low voltage L to a high voltage H, as shown in FIG. **3**B. Hence the sensing signal generated from the infrared ray sensor **11** is a binary signal readable to the program written in the OTPROM memory of the microcontroller **12**. The microcontroller based electronic switch **1** utilizes specific sensing signal format characterized by the time length Ts of the low voltage sensing signal to implement at least two functions, namely, on/off switch control and dimming control. By introducing a preset time To, the microcontroller **12** can execute subroutine corresponding to the functions of the on/off switch control, the color temperature tuning control and the illumination power dimming control determined by a comparison scheme of the time length Ts with the preset time To. The user can therefore operates the microcontroller-based electronic switch **1** in a convenient manner simply by moving his hand into or out of the infrared ray detecting zone of the infrared ray sensor **11**, and staying his hand there for a time period to select desired performance function.

Referring to FIG. **2**, FIG. **3** and FIG. **4**, FIG. **4** is a flow chart of a program executed in a microcontroller of a microcontroller based electronic switch according to an exemplary embodiment of the present disclosure. The program written in the OTPROM memory of the microcontroller **12** includes several subroutine loops. These loops are started from the loop of steps S**1** through S**6** of the on/off switch control mode, and may jump into the loop of steps S**8** through S**10** of the color temperature tuning mode (or the dimming control mode) according to the time length Ts of the low voltage sensing signal. The pin pin_**3** of the microcontroller **12** receives a high voltage H or a low voltage L from the infrared ray sensor **11**, wherein the time length Ts of the low voltage sensing signal is about the time length which the user's hand stays within the infrared ray detecting zone.

The program of the microcontroller **12** starts its execution from the loop of steps S**1** and S**2** in which the microcontroller based electronic switch **1** is off. The program of the microcontroller **12** scans the voltage at the pin pin_**3** of the microcontroller **12**. If the voltage at the pin pin_**3** of the microcontroller **12** is high (bit **1**), the program of the microcontroller **12** stays in the loop of steps S**1** and S**2** that the microcontroller based electronic switch **1** is off. On the contrary, if the voltage at the pin pin_**3** is low (bit **0**), the program of the microcontroller **12** jumps into the loop of steps S**3** through S**6** in which the microcontroller based electronic switch **1** is on. At step S**4** when the microcontroller based electronic switch **1** is on, the program of the microcontroller **12** scans the voltage at the pin pin_**3** of the microcontroller **12**. If the voltage at the pin pin_**3** of the microcontroller **12** is low (bit **0**), the program of the microcontroller **12** jumps to step S**5** to compare the time length Ts with a preset time To. In practice, the preset time To is between 1 through 3 seconds, but the present disclosure is not limited thereto.

At step S**5**, the program of the microcontroller **12** check the time length Ts, if Ts is shorter than the preset time To, step S**5** proceeds to step S**6** to detect whether the voltage at the pin pin_**3** is momentary a high voltage H (bit **1**). At step S**6**, if the voltage at the pin pin_**3** is the voltage H, the program goes back to the loop of steps S**1** and S**2** in which the microcontroller based electronic switch **1** is off. At step S**6**, if the voltage at the pin pin_**3** is low, the program remains in the loop of steps S**3** through S**6** in which the microcontroller based electronic switch **1** is on.

To sum up, the on/off switch control mode is described by the loops consisting of steps S**1** through S**6** that the microcontroller based electronic switch **1** is operated in off- and on-state rotationally. The microcontroller based electronic switch **1** is on or off according to whether the user moves his hand into and then pulls out the infrared ray detecting zone of the infrared ray sensor **11** within the preset time To.

At step S**5**, the program of the microcontroller **12** check the time length Ts, if the time length Ts is longer than the preset time To, the program jumps to step S**7** to detect whether the time length Ts is longer than n times the preset time To ($n \geq 2$). At step S**7**, if the time length Ts is not longer than n times the preset time To, the program goes back to the loop of steps S**3** through S**6** that the microcontroller based electronic switch **1** remains on. At step S**7**, if the time length Ts is longer than n times the preset time To, the program

jumps into a loop consisting of steps S**8** through S**10** to execute a subroutine for the color temperature tuning mode (or the dimming control mode) of microcontroller based electronic switch **1**. FIG. **4** does not show the details of subroutine associated with the color temperature tuning mode (or the dimming control mode), but the process is described in short as follows. At step **9**, the program of the microcontroller **12** scans the voltage at the pin pin_**3** of the microcontroller **12**. The program proceeds to step **10** from Step **9**, if the voltage at the pin pin_**3** is low. At step **10**, the subroutine of the microcontroller **12** checks if Ts>nTo. If the voltage at the pin pin_**3** is low for several times, and the time lengths denoted by Ts or Ts' are shorter than n times the preset time To, the subroutine remains in the rotation loop defined by step **8** through S**10**, and microcontroller **12** continuously increases or decreases the electric power transmission to the lighting loads **2***a*, **2***b* by controlling the conduction rates. If the electric power of the lighting load reaches the maximum or minimum electric power, the program of the microcontroller **12** responds no more to the low voltage sensing signal. At step **10**, if the time length Ts is longer than n times the preset time To, the program of the microcontroller **12** jumps back to the loop of steps S**1** and S**2** in which the microcontroller based electronic switch **1** is off. Then, the program of the microcontroller **12** resumes itself from steps S**1** and S**2** in a rotational manner to execute the subroutines represented by the steps shown in FIG. **4**.

In the exemplary embodiment of FIG. **2**, the preset time To and the number n can be set 2 seconds and 2, respectively. Referring to the steps executed by the microcontroller **12** in FIG. **4**, if the detected time length Ts of the low voltage sensing signal at the pin pin_**3** is less than 2 seconds, that means the time period which the hand stays within the infrared ray detecting zone is less than 2 seconds, the microcontroller **12** remains in the current function mode. If the detected time length Ts at the pin pin_**3** is longer than 4 seconds, that means the time length which the hand stays within the infrared ray detecting zone is longer than 4 seconds, the microcontroller **12** changes the current function mode to another one function mode. In other words, if the time length Ts of the low voltage sensing signal is shorter than the preset time To, the microcontroller **12** operates either in on/off switch control mode or in color temperature tuning mode (or dimming control mode). If the detected time length Ts of the low voltage sensing signal is longer than n times the preset time To, the microcontroller **12** changes its program execution from the on/off switch control mode into the color temperature tuning mode (or the dimming control mode) and vice versa.

In another embodiment, the concept of the present disclosure can be further extended to implement a multifunctional electronic switch having at least three functions built in one, which are on/off switch control, illumination dimming control and color temperature management. The program written in the OTPROM memory of the microcontroller can be modified in such a manner that the microcontroller responds not only to the low voltage sensing signal of the infrared ray sensor, but also to a specific sequence of the sensing signals. The microcontroller executes subroutines of working modes corresponding to the said three functions according to the detected time length Ts and special sequence of the low voltage sensing signals. The first working mode is on/off switch control mode used to control the conduction or cut-off state of the controllable semiconductor switching elements. The second working mode is dimming control mode used to control the conduction rates of the controllable semiconductor switching elements. The third working mode is color temperature management mode used to change alternatively from a high color temperature to a low one, or vice versa, or to tune the color temperature of the diffused light from two lighting loads. When the infrared ray sensor generates a low voltage sensing signal within the preset time To, the microcontroller operates in the on/off switch control mode by controlling the conduction or cut-off state of both the controllable semiconductor switching elements alternately. If the time length Ts of the low voltage sensing signal is longer than n times the preset time To, the microcontroller changes its operation from the on/off switch control mode to the color temperature tuning or dimming control mode. Once in the dimming (tuning) control mode, the microcontroller executes subroutine to gradually change the conduction rates of the controllable semiconductor switching elements from the maximum conduction rate to the minimum conduction rate, and then to gradually change the conduction rate from the minimum conduction rate to the maximum conduction rate for completing a dimming cycle wherein the process is a free run. In the dimming cycle with free run, the moment when the infrared ray sensor provides a high voltage is a dimming end point. According to the dimming control mode design, the microcontroller locks the conduction rates of the controllable semiconductor switching elements at the dimming end point. Thereafter, if the infrared ray sensor generates a plurality of low voltage sensing signals, for instance, a plural signal of two consecutive sensing signals, each within the preset time To, the microcontroller operates in the color temperature management mode by executing a subroutine to select a color temperature of the diffused light from two lighting loads through controlling different power levels delivered to the two lighting loads of different color temperatures. It is clear to see the advantage of the present disclosure to integrate various switch control functions in one without changing the hardware circuit design. All are simply done by defining the format of sensing signals and by modifying the program written in the OTPROM memory in the microcontroller.

As mentioned above, various switch control functions can be integrated in one without changing the hardware circuit design of the microcontroller and the two loads. There may be variations of detection device in using electronic switch of the present disclosure for touch and touch less applications. For example, (1) Dual detection device technology in which two detection device are integrated in one electronic switch, for instance, by connecting two infrared ray sensors respectively with two pins of the microcontroller **12** in FIG. **1**, to control a lighting apparatus: one first detection device sending message carrying sensing signal to control the color temperature of illumination characteristic, one second detection device sending message carrying sensing signal to control the light intensity of illumination characteristic; (2) Single detection device technology in which one detection device is built in an electronic switch to generate message carrying sensing signal to control a lighting apparatus by using different types of signal formats: a first type sensing signal (for instance, a low voltage within a short preset time To) to control the on/off performance, a second type sensing signal (for instance, a low voltage with a long time length Ts) to control the switching between low color temperature mode and high color temperature mode, and a third type sensing signal (for instance, a plural signals of two consecutive low voltages) for dimming the light intensity of illumination characteristic; (3) Single detection device technology using free running technique in response to a specific format sensing signal to offer selection of color temperature.

The free running subroutine can be designed to apply to an electronic switch installed on wall for managing the illumination characteristics of a remotely located lighting apparatus such as a ceiling light installed on the ceiling. Unless a wireless communication unit is employed, a typical wall switch is constrained by a single circuit to only perform one illumination characteristic, being either controlling the light intensity or controlling the color temperature. If both the color temperature and light intensity are required to manage, the only way is to use the free running technology to execute one of the two illumination characteristics. The free running subroutine can be so deigned such that whenever a power supply is on, the microcontroller with software subroutine will check the memory unit to see if a preset color temperature or light intensity is established to decide if the free running subroutine needs to be activated, in the absence of preset datum, a free running action will be activated to gradually change the lighting intensity from maximum intensity to minimum intensity and continuously from minimum intensity to maximum intensity for completing a tuning/dimming cycle on an automatic basis and at any moment during a tuning/dimming cycle the user can determine the light intensity by acting a motion signal to lock in the level of the light intensity. The automatic tuning/dimming only continues for a short duration and in the absence of selection by the user, the microcontroller with program codes will execute a predetermined lighting intensity. Similarly, the same mechanism can be applied for tuning the color temperature to allow the user to select the desired color temperature during a free tuning cycle by acting a motion signal with the detection device to lock in the desired level of color temperature. With the help of free running technology, the wall control unit can therefore be used solely for operating the remaining illumination characteristic.

The concept of free running technology can be further applied to develop a life style LED lighting solution where the color temperature is gradually changed according to time schedule programmed for performing different color temperature catering to the living style of human beings that people are more used to low color temperature with a warm atmosphere during the night time from 7 PM through 5 PM while during the day time people are more used to the high color temperature for working hours. A clock can be employed to provide the time information necessary for working with a program of scheduled color temperature pattern. The conduction rate **r1** of the first controllable switching element can be varied in a reverse direction with respect to the conduction rate **r2** of the second controllable switching element, the microcontroller with program codes executes to vary the conduction rate of the first controllable switching element according to a programmed pattern of color temperature changes in a subroutine; when **r1** is equal to zero, the first controllable switching element is in a cutoff state while the second controllable switching element is in a full conduction state, the lighting apparatus performs a low color temperature, 3000K for instance, which may be the desired color temperature for the night time from 7 PM to 5 PM, when **r1** is maximum, the first controllable switching element is in a full conduction state while the second controllable switching element is in a cut off state, the lighting apparatus performs a high color temperature, 5000K for instance, which may be the desired color temperature for noon time at 12 PM. A single color temperature may be assigned for night period from 7 PM through 5 AM for the sleeping time. For day time it can be programmed to gradually change the values of **r1** and **r2** from maximum to 0 between 5 AM to 12 PM and from 0 to maximum between 12 PM to 7 PM. With such arrangement at any time when the power is turned on the lighting apparatus automatically performs a desired color temperature according to the programmed pattern of color temperature at scheduled time frame.

Refer to FIG. **5**, FIG. **6** and FIG. **7** in accompanying FIG. **2** and FIG. **4**. According to an exemplary embodiment of the present disclosure, FIG. **5** is a voltage waveform diagram of a microcontroller based electronic switch in cut-off state when operating in on/off switch control mode, FIG. **6** is a voltage waveform diagram of a microcontroller based electronic switch in conduction state when operating in on/off switch control mode, and FIG. **7** is a voltage waveform diagram of a microcontroller based electronic switch when operating in dimming control mode. In FIG. **5**, FIG. **6**, and FIG. **7**, the voltage waveforms as shown from the top are, respectively, a sine wave output from the AC power source **3**, an output signal of the zero-crossing-point detector **13** that is fed to pin pin_**10** of the microcontroller **12**, an output signal from the pin pin_**1** of the microcontroller **12**, and a voltage waveform between the two ends of the load **2***a*. The voltage waveforms are used to describe the interactions related to the program of the microcontroller **12** and the microcontroller based electronic switch **1** in the above mentioned two working modes. As already described above, the voltage signal generated by the zero-crossing-point detector **13** is a square wave with a low and a high voltage, which is fed to the pin pin_**10** of the microcontroller **12** and, to be explained later, served as an external interrupt trigger signal. The voltage signal from the pin pin_**1** of the microcontroller **12** is sent to the gate of the triac T**1***a* to control the conduction state of the triac T**1***a*. In the same way, the similar voltage signal from the pin pin_**2** of the microcontroller **12** is sent to the gate of the triac T**1***b* to control the conduction state of the triac T**1***b*.

In the program loops corresponding to the on/off switch control mode and the dimming control mode, the microcontroller **12** utilizes the external interrupt control technique to generate voltage pulses synchronized with AC power. To accomplish it, the program of the microcontroller **12** has a setup with the voltage level variations at the pin pin_**10** as external interrupt trigger signals. Since the time point of high or low voltage level variation in the signal generated by the zero-crossing-point detector **13** is the zero crossing point of AC sine wave, the external interrupt process is automatically triggered at the zero crossing point of the AC power source **3**, and the related meaning of the details are further described in FIG. **6** and FIG. **7**.

Referring to FIG. **5** in accompanying FIG. **2** and FIG. **4**, the program of the microcontroller **12** starts from the loop of steps S**1** and S**2** of on/off switch control mode, wherein the microcontroller based electronic switch **1** is off. The program of the microcontroller **12** scans the voltage at the pin pin_**3**. If the voltage at the pin pin_**3** is a high voltage, the microcontroller **12** generates a zero voltage at the pin pin_**1**, which is fed to the gate of the triac T**1***a* to turn it off. For no current flowing through the triac T**1***a*, the voltage between the two ends of the load **2***a* is zero in each AC cycle. In the same way, if the voltage at the pin pin_**3** is a high voltage, the microcontroller **12** generates a zero voltage at the pin pin_**2**, which is fed to the gate of the triac T**1***b* to turn it off.

Refer to FIG. **6** in accompanying FIG. **2** and FIG. **4**. If the program of the microcontroller **12** detects a low voltage at the pin pin_**3**, the program of microcontroller **12** jumps to steps S**3** and S**4** of on/off switch control mode, wherein the microcontroller based electronic switch **1** is on. The microcontroller **12** scans within a few microseconds the voltage at

the pin pin_10. The external interrupt happens in each AC half cycle (of some milliseconds) at the time point of voltage level variation in the square wave signal. In the external interrupt process, no other program is executed, instead the program is commanded to go back to the main program instantly. The program of the microcontroller **12** is designed based on the time point when the external interrupt occurs, which is also the zero crossing point of the AC power source **3**. After some delay times with respected to the time point of the external interrupt, the program of the microcontroller **12** generates a pulse signal at the pin pin_**1** and a pulse signal at the pin pin_**2**. The signal provided from the pin pin_**1** is a zero-crossing-point time-delay pulse having a delay time tD_a after the zero crossing point of AC power. The signal provided from the pin pin_**2** is a zero-crossing-point time-delay pulse tD_b having a delay time tD_b after the zero crossing point of AC power. The zero-crossing-point time-delay pulse tD_a (or tD_b) is generated both in the positive and negative half-cycle of the AC power source **3**, and used to trigger in synchronization with AC power source **3** the triac T**1***a* (or triac T**1***b*) into conduction, such that the AC power source **3** delivers in each half AC cycle electric power to the first lighting load **2***a* (or the second lighting load **2***b*) which is in proportion to a conduction time ton_a of the triac T**1***a* (or ton_b of triac T**1***b*). In contrast with the AC power source **3** and the zero crossing point delay pulses, the voltage waveform on the first lighting load **2***a* is depicted in FIG. **6**, and the conduction time ton_a is designated. The voltage waveform on the second lighting load **2***b* can be similar to the voltage waveform on the first lighting load **2***a*, wherein the conduction time ton_b of triac T**1***b* can be different from the conduction time ton_a of the triac T**1***a* which are respectively resulted from different delay time tD_b and delay time tD_a of the zero-crossing-point time-delay pulses.

In the loop of steps S**3** and S**4** of the microcontroller based electronic switch **1** being on, the delay times tD_a and tD_b of the zero-crossing delay voltage pulses are both predetermined values to make a constant average electric power delivered to the loads **2***a*, **2***b*. The color temperature of the diffused light of the two lighting load **2***a*, **2***b* may be controlled by properly selecting tD_a and tD_b, such that the summation of tD_a and tD_b is a constant, and the total lighting power of the first lighting load **2***a* (X) and the second lighting load **2***b* (Y), X+Y, is a fixed value. However, it is not to limit thereto in the present disclosure. By designing a minimum time delay, summation of the conduction time ton_a and ton_b of the triac T**1***a* and the triac T**1***b* can reach the maximum to make the maximum electric power transmission to the loads **2***a*, **2***b*. In practice, the loads **2***a*, **2***b* can be fluorescent lamps, AC LEDs (light emitting diode) screwed-in LED bulbs or incandescent bulbs, wherein said light-emitting diode module comprises a full-wave rectifier bridge and a plurality of light-emitting diodes in series connected between the two terminals of the rectifier bridge output port. Alternatively, the two loads **2***a*, **2***b* can be DC LED modules power by a DC source.

Refer to FIG. **7** in accompanying FIG. **2** and FIG. **4**. In the loop of steps S**3** through S**6**, the microcontroller based electronic switch **1** is on, the program of the microcontroller **12** scans the voltage at the pin pin_**3**. If the sensing signal fed to the pin pin_**3** is a low voltage with the time length Ts longer than nTo (n≥2), the program of the microcontroller **12** jumps to the loop of steps S**8** through S**10** for executing the color temperature tuning mode. When the microcontroller based electronic switch **1** is in the color temperature tuning mode, the program of the microcontroller **12** scans the voltage at the pin pin_**10**, so as to generate a zero-crossing-point time-delay pulse with a delay time tD_a at the pin pin_**1** and to generate a zero-crossing-point time-delay pulse with a delay time tD_b at the pin pin_**2**. Simultaneously, the program of the microcontroller **12** scans the voltage at the pin pin_**3**. If the detected sensing voltage at the pin pin_**3** is a low voltage with different time length Ts, the program continuously increases the delay time tD_a and decreases the delay time tD_b, or vice versa, of the zero-crossing-point time-delay pulses generated respectively at the pin pin_**1** and pin pin_**2**, wherein the varying time length tD_a and tD_b are in proportion to the time length Ts. It should be noted that both delay times tD_a and tD_b vary in an appropriate range from "t_o" to "$1/(2f)-t_o$", wherein $t_o=(½\pi f)\sin^{-1}(V_t/V_m)$, f is the AC frequency, V_t is the threshold voltage or cut-in voltage of the lighting loads **2***a*, **2***b* and V_m is the voltage amplitude of the AC power source **3**. This constraint on tD_a and tD_b is required to ensure in each AC half-cycle to stably trigger the triac T**1***a* and triac T**1***b* into conduction when the threshold voltage V_m of the lighting loads **2***a*, **2***b* are taken into consideration. FIG. **7** shows for one case the waveforms in the color temperature tuning mode wherein the delay time tD_a of the time delay pulse at the pin pin_**1** is gradually increased along the time axis. The delay time tD_a decides the time length of the conduction time ton_a of triac T**1***a*. The average electric power delivered to the first lighting load **2***a*, which is in proportion to the time length ton_a, is accordingly decreased. At the same time for the same case, not shown in FIG. **7**, the delay time tD_b of the time delay pulse at the pin pin_**2** is gradually decreased in the reverse direction, the conduction time ton_b of triac T**1***b* and the average electric power delivered to the second lighting load **2***b* are thus accordingly increased. Consequently, the color temperature of the diffused light of the two lighting load **2***a*, **2***b* may vary gradually from a high temperature to a low one, or vice versa, due to alternatively changing the power levels of the two lighting load **2***a*, **2***b* controlled by the trigger pulses with delay times tD_a and tD_b. When the voltage at the pin pin_**3** becomes high to terminate the color temperature tuning mode, the final values of the delay times tD_a and tD_b are then stored in the memory of the microcontroller **12** as new predetermined values to perform illumination with a desired color temperature and power level.

In addition, the concept of the present disclosure can also be applied to the DC power source, wherein the controllable semiconductor switching element and the program of the microcontroller **12** should be modified slightly, and the zero-crossing-point detector should be removed. Referring to FIG. **8**A, FIG. **8**A is a block diagram of a microcontroller based electronic switch **1'** using an infrared ray sensor as a detection device for a DC power source according to an exemplary embodiment of the present disclosure. The microcontroller based electronic switch **1'** is connected to a DC power source **3'** and a first lighting load **2'***a* in a serial fashion, so as to control the electric power of the DC power source **3'** delivered to the first lighting load **2'***a*. Also, the microcontroller based electronic switch **1'** is connected to the DC power source **3'** and a second lighting load **2'***b* in a serial fashion, so as to control the electric power of the DC power source **3'** delivered to the second lighting load **2'***b*. Compared to FIG. **1**, the microcontroller based electronic switch **1'** in FIG. **8**A comprises an infrared ray sensor **11'**, a microcontroller **12'**, and uni-directional controllable semiconductor switching elements **14'***a*, **14'***b*. In practice, the uni-directional controllable semiconductor switching elements **14'***a*, **14'***b* can be bipolar junction transistors (BJTs) or

metal-oxide-semiconductor field-effect transistors (MOSFETs). The loads **2'**a and **2'**b can respectively emit low color temperature light and high color temperature light. The load **2'**a and **2'**b can be light-emitting diodes or incandescent bulbs, but present disclosure is not limited thereto.

Referring to FIG. **3** and FIG. **8**B, the infrared ray sensor **11'** detects a user's hand, for instance, and converts the outcome into message carrying low voltage sensing signals readable to the microcontroller **12'**. The microcontroller **12'** decodes the low voltage sensing signal according to the program designed and written in its OTPROM, so as to make the microcontroller based electronic switch **1'** operate in on/off switch control mode and color temperature tuning mode (or dimming control mode) accordingly. In the on/off switch control mode when the microcontroller based electronic switch **1'** is off, the program of the microcontroller **12'** generates a zero voltage fed to the gate of the uni-directional controllable semiconductor switching element **14'**a (or **14'**b) so as to turn off the switching element **14'**a (or **14'**b). In the on/off switch control mode when the microcontroller based electronic switch **1'** is on, the program of the microcontroller **12'** generates PWM_a (pulse-width-modulation) (or PWM_b) signal fed to the gate of the uni-directional controllable semiconductor switching element **14'**a (or **14'**b) so as to turn on the switching element **14'**a (or **14'**b) such that a fixed electric power is transmitted from the DC power source **3'** to the load **2'**a (or **2'**b).

FIG. **8**B is a voltage waveform diagram of the PWM signals according to an exemplary embodiment of the present disclosure. The PWM voltage signal is a square wave signal comprising a zero voltage (or low-voltage) and a high voltage, wherein the high voltage drives the uni-directional controllable semiconductor switching element **14'**a (or **14'**b) into conduction. If the time length of the high voltage is T_{2a} (or T_{2b}) and the period of the PWM voltage signal is T_1, the average electric power delivered to the load **2'**a (or **2'**b) through the uni-directional controllable semiconductor switching element **14'**a (or **14'**b) is proportional to the ratio T_{2a}/T_1 (or T_{2b}/T_1), which is by definition the duty cycle of the PWM voltage signal and is denoted as $\delta=T_{2a}/T_1$ (or $\delta=T_{2b}/T_1$).

More specifically, the electronic switch **1'** controls on/off and dimming of the first lighting load **2'**a and the second lighting load **2'**b in response to the operation of the infrared ray sensor **11'**. When the switch **1'** is turned on, the microcontroller **12'** sends PWM voltage signals PWM_a and PWM_b for FIG. **8**A controlled by the infrared ray sensor **11'**: as shown, it is always to generates voltage signals PWM_a and PWM_b with two predetermined time lengths of T_{2a} and T_{2b}, wherein $T_{2a}+T_{2b}=T_1$ for respectively controlling the load **2**a to generate X watts power illumination and the load **2**b to generate Y watts power illumination, where the summation X+Y is a fixed value. It may be $T_{2a}<T_{2b}$ or $T_{2a}>T_{2b}$ in response to the control signal generated by infrared ray sensor **11'**. In a free running mode for color temperature tuning in response to the control signal generated by infrared ray sensor **11'**, T_{2a} may be varied gradually from a large value to a small one while T_{2b} varied gradually from a small value to a large one, and vice versa, wherein $T_{2a}+T_{2b}=T_1$. A color temperature generated by blending the lights emitted from the lighting load **2'**a and **2'**b can thus be selected when the free running mode for color temperature tuning is terminated by moving object (for example, the user's hand) out of the detecting zone of the infrared ray sensor **11'**, and then the final values of T_{2a} and T_{2b} would be stored in the memory of the microcontroller **11'**.

The present disclosure is not limited by the PWM waveforms as depicted in FIG. **8**B. In a practical design scheme, the parameters T_{2a} and T_{2b} of the PWM voltage signals can have a relation $T_{2a}+T_{2b}=A$, wherein "A" is a predetermined constant. Since the average electric powers delivered to the lighting loads **2'**a and **2'**b are respectively proportional to the duty cycles T_{2a}/T_1 and T_{2b}/T_1, both are smaller than one, the total average lighting power is in proportion to the summation of T_{2a}/T_1 and T_{2b}/T_1. When the voltage signals PWM_a and PWM_b are designed with A>T**1**, the color temperature of the diffused light of the two lighting load **2**a, **2**b can be generated under a total average lighting power larger than the one when A=T**1**. With A<T**1**, the total average lighting power is smaller than the one when A=T**1**. Thus, besides the color temperature tuning, the illumination power level may be controlled through varying the parameter A in a predetermined range by the microcontroller based electronic switch **1'** of the present disclosure.

The aforementioned microcontroller-based electronic switch can have many functions, such as on/off switch control, dimming control and color temperature tuning or management control, that are integrated in one without additional hardware complexity. This multifunctional electronic switch can be applied to a lighting apparatus. Please refer to FIG. **9**A, a lighting apparatus having the microcontroller-based multifunctional electronic switch is provided. The lighting apparatus comprises a base **91**a, a first lighting load **92**a, a second lighting load **93**a, a diffuser **94**a and a microcontroller based electronic switch (not shown in the figure). The base **91**a is for disposing the first lighting load **92**a, the second lighting load **93**a and the microcontroller based electronic switch which has been described in previous embodiments. The operation of the microcontroller based electronic switch related to lighting characteristic control of the first lighting load **92**a and the second lighting load **93**a can be referred to previous embodiments, thus the redundant information is not repeated. For diffusing or spreading out or scattering the different color temperature light emitted by the first lighting load **91**a and the second lighting load **92**a, a diffuser **94**a is provided to cover the first lighting load **92**a and the second lighting load **93**a. Further, the first lighting load **92**a and the second lighting load **93**a can be alternatively disposed on the base **91**a. As shown in FIG. **9**B, the first lighting load **92**a comprises a plurality of lighting elements, and the second lighting load **93**a comprises a plurality of lighting elements, wherein a lighting element of the second lighting load **93**a is inserted between the two adjacent lighting elements of the first lighting load **92**a for obtaining uniform color temperature of the diffused light, but present disclosure is not limited thereto.

Another embodiment of the lighting apparatus can be referred to FIG. **9**B. Due to the difference for the appearance of the lighting apparatus, the arrangement of the lighting elements of the first lighting load **92**a and the lighting elements of the second lighting load **93**a shown in FIG. **9**B is different from that shown in FIG. **9**A. As shown in FIG. **9**B, the lighting elements of the first lighting load **92**a and the lighting elements of the second lighting load **93**a are both disposed in a circular arrangement. The lighting elements of the first lighting load **92**a and the lighting elements of the second lighting load **93**a constitute a plurality of concentric circles. The concentric circles of the first lighting load **92**a and the concentric circles of the second lighting load **93**a are interlaced for obtaining uniform color temperature of the diffused or blended light. However, the present disclosure is not restricted thereto. An artisan of ordinary skill in the art will appreciate how to arrange the first

lighting load and the second lighting load covered by the diffuser to obtain the result of uniform color temperature of light.

Furthermore, although the above description of the exemplary embodiments takes infrared ray sensor as a means for detecting user's motion and generating sensing signal, the technology of the present disclosure has no restriction on the types of detection method used. There are quite a few detection methods including touch or touchless means that can be applied to the present invention of the multifunctional electronic switch such as an infrared ray sensor (touchless interface), an electrostatic induction sensor (also touchless interface), a conduction based touch sensor (direct touch interface), or a push button sensor (direct touch interface). Each detection method may require different motion signals to be played by the user but the core technology remains using the time length and format of the binary sensing signals as the message carrier for transmitting the user's choice of working mode. The microcontroller thereby decodes or interprets the received message carrying sensing signals according to the software program written in the OTPROM, recognizes the working mode selected by the user and activates the corresponding loop of subroutine for performance execution.

Similar to the infrared ray sensor, the electrostatic induction sensor can also create a touchless interface. The electrostatic induction sensor generally comprises a copper sheet sensing unit with adequately design shape and packaged with non-conductive material. Such copper sheet sensing unit is further electrically connected to a signal generating circuit similar to the infrared detection sensor unit. The copper sensing unit serves as an anode pole and the human body (normally refers to finger or hand) serves as a cathode pole to form a configuration of a capacitor. When the user's hand is approaching the copper sensing unit, the electric charges are being gradually induced and built up on the surface of the copper sensing unit with increasing density. Consequently, the copper sensing unit changes its electric state from zero voltage state to a growing voltage state. Such voltage level will continue to grow as the user's hand moving closer and closer to the copper sensing unit till reaching a designed threshold point which will trigger the detection circuit to generate a low voltage sensing signal. The distance between the copper sensing unit and the space point where the threshold voltage incurs is defined as the effective detecting zone. Similarly but reversely when the user's hand is moving out from an operative point of the detecting zone of the copper sensing unit, the voltage level will continue to decline till passing the designed threshold point which will trigger the cutoff of the low voltage sensing signal. The time length of the low voltage sensing signal so generated or in other words the time period between moving in and moving out the effective detecting zone can be designed to represent the selection of different working modes. If the time length is shorter than a preset time interval, it means the user's selection is to perform the on/off switch control mode; if the time length is longer than a preset time interval, it means the user's selection is to perform the diming or power level control mode; if two or more low voltage sensing signals are consecutively generated within a preset time interval, in other words the user's hand moving in and out the detecting zone twice or swing across the detecting zone back and forth, it means the user's selection is to perform the color temperature management mode.

For direct touch detection sensors, such as a touch sensor (for example a touch pad) or a push button detection sensor, one touch on the conductive base or one instant press on the control button within a preset time interval will trigger the generation of a single sensing signal which will cause the microcontroller to execute the subroutine of the on/off switch control mode; a long touch on a conductive base or a long press on a control button longer than the preset time interval will trigger the generation of a single sensing signal with time length longer than the preset time interval and the microcontroller responsively will execute the subprogram of dimming control mode. Double instant touches on the conductive base or double instant press on the control button within a preset time interval will trigger the generation of two consecutive sensing signals which will cause the microcontroller to execute the subroutine of color temperature management mode.

FIG. **10**A and FIG. **10**B together provide a good show case to prove the value of the user friendly concept of the present invention. Picture shown in FIG. **10**A is a popular piece of under cabinet light with LED as light source. A manual on/off control switch is built on the right hand side of the rectangular housing and a dimming knob is built on the front panel facing downward. Under cabinet lights are always installed underneath the kitchen cabinets to provide sufficient indirect illumination to the user to do the kitchen work. The under cabinet lights and the kitchen cabinet are always installed at approximately the breast level of the users for the convenience of doing kitchen work so that the users can comfortably do the kitchen work without bending their body and having to work in a glaring environments. The current market piece as shown in FIG. **10**A is not an user friendly device; the user has to either use his or her hand to blindly search the locations of the on/off switch and the dimming knob or to bend his or her body to find the exact locations of the two control units for operation. Additionally, the direct touch to control the on/off switch and dimmer also brings up concerns of contagion and contamination in preparing food in kitchen area and the housewives may have to wash their hands more frequently than necessary.

FIG. **10**B is an application of the present invention for a LED under cabinet light featured with a touchless interface between the user and the under cabinet light. A motion of single swing of user's hand across the detecting zone of the microcontroller based electronic switch **1***b* will activate the on/off switch mode alternately turning on and turning off the under cabinet light **2***b*. A motion of placing user's hand in the detecting zone exceeding a preset time interval will activate the dimming mode to allow selection of brightness or power level. And a motion of double swings of user's hand across the detecting zone within a preset time interval will activate the color temperature tuning mode to provide the user a possibility to select a desired illumination color temperature. The three basic working modes can be easily managed with simple motions played by the user without the hassles of having to blindly search the control switch and dimming knob, or to bend body to find the location of the control elements or to frequently wash hands to avoid concerns of contagion and contamination in preparing food. This is truly a very user friendly exemplary embodiment of the present disclosure compared with what are currently being sold in the market as shown in FIG. **10**A.

FIG. **10**C is another application of the present invention for a wall switch construction electrically connected to a ceiling light for the performance of three working modes. A motion of single swing across the detecting zone in front of the wall switch **1***c* by user's hand within a preset time interval will activate the on/off switch control mode alternately turning on and turning off the ceiling light **2***c*. A

motion of placing user's hand in front of the wall switch **1***c* and stay in the detecting zone for a time period longer than a preset time interval will activate the dimming mode to allow the user to select the desired brightness. And a motion of double swings across the detecting zone within a preset time interval will activate the performance of the color temperature management mode to provide the user a convenient way to select a desired illumination color temperature. This new wall switch when compared with conventional switch represents a very user friendly innovation from the easy operation point of view. The conventional touch based wall switch is also a virus gathering spot because of use by many users and the issue of contagion and contamination is always a valid concern even outside the surgical space.

FIG. **10**D is another application of the present invention for a lighting apparatus with a diffuser of hollow body accommodating the lighting loads and the microcontroller based electronic switch. The diffuser is furthered bonded with a metallic threaded cap with bipolar construction for connecting with a power socket. FIG. **10**E is a similar art with a flat diffuser bonded with a metal shade to accommodate the lighting loads and the microcontroller based electronic switch. Both have an infrared ray sensor **310** positioned at the bottom of the diffuser to form a short detection zone for an user to play motion signals for performing the multi functions of controlling on/off mode, dimming mode, color temperature tuning mode or delay shutoff mode.

FIGS. **11**A-D are another exemplary embodiments of the present invention using the aforementioned dual detection device technology for generating message carrying sensing signal to control a lighting apparatus. The dual detection device technology is based on two detection device which are respectively connected with two pins of a microcontroller in an electronic switch to control a lighting apparatus, such as, one first detection device generating message carrying sensing signal to control the color temperature of illumination and one second detection device generating message carrying sensing signal to control the light intensity of illumination. The dual detection device technology can be constructed in two arrangements: the first arrangement is to install the first detection device on one side (left side for instance) of the lighting apparatus and install the second detection device on the other side (right side) of the lighting apparatus. For instance, in FIG. **10**B, the detection device **1***b* being an infrared ray sensor in the center can be relocated to the left side near the end cap as the first detection device to operate the light intensity control subroutine of microcontroller, a second infrared ray sensor as the second detection device is added and installed on the other end of the light apparatus to operate the color temperature control subroutine. The second arrangement is to have two detection device, here, two infrared ray sensors **310**, aligned next to each other along the direction of motion path as shown in FIG. **11**A and FIG. **11**B, or in FIG. **11**C and FIG. **11**D. A hand swing from left side to enter the detecting zones formed by the two infrared ray sensors **310**, as shown in FIG. **11**A and FIG. **11**C, will cause the first infrared ray sensor of the electronic switch to first detect the motion signal before the second infrared ray sensor can detect the same motion signal, the first infrared ray sensor will thereby generate a voltage sensing signal, the microcontroller with a pin connected with the first infrared ray sensor accordingly interprets such voltage sensing signal to activate a subroutine to operate the light intensity control mode. Thus, a first hand-swing from the left side to swing across the detecting zones will turn on the light, a second left side started hand swing will alternately change the light to perform a different state of light intensity including off mode, a left side started hand swing to enter the detecting zones and stay for a time length longer than a preset time interval will activate a free running dimming cycle for the user to select the desired light intensity. Similarly but contrarily in terms of direction for playing motion signal, a right side started hand swing to swing across the detecting zones formed by the two infrared ray sensors, as shown in FIG. **11**B and FIG. **11**D, will cause the second infrared ray sensor to first detect the motion signal before the first infrared ray sensor can detect such motion signal, the second infrared ray sensor thereby will generate another voltage sensing signal sending to the microcontroller of the electronic switch, the microcontroller with another pin connected to the second infrared ray sensor accordingly operates to activate a different subroutine of the microcontroller to operate the color temperature tuning mode. Thus, a right side started motion signal to swing across the detecting zones formed by the two infrared ray sensors will turn on the light to perform the highest color temperature mode, a second right side started motion signal to swing across the detecting zones will alternately change the light to perform a different state of programmed color temperatures including the lowest color temperature mode, a right hand started motion signal to enter and stay in the detecting zone for a time length longer than a preset time interval will activate a free running color temperature tuning cycle for the user to select a desired color temperature for the light. Also, when the hand (or an object) leaves the infrared ray detecting zones, the infrared ray sensors deliver a second voltage sensing signal to terminate the corresponding subroutine.

The present invention of the microcontroller based electronic switch can be extensively used in the control of lighting performance for many I applications can be simply grouped into three main categories of application based on the installation location of the present invention in relation with the lighting devices used as follows:

1) The microcontroller based electronic switch is installed inside a wall electric outlet for controlling a remotely located lighting apparatus which users are unable to reach to play motion control. FIG. **10**C is a representative example.
2) The microcontroller based electronic switch is installed inside the housing of a lighting apparatus which users are able to reach and play motion control. FIG. **10**B of a under cabinet light is a representative example.
3) The microcontroller based electronic switch is directly installed inside a light emitting device with a detecting sensor hiding behind a diffuser and a detecting zone is formed outside nearby the diffuser. FIG. **10**D is a light bulb application with a microcontroller electronic switch built inside the bulb and an infrared ray detecting sensor installed at bottom of the bulb to form a infrared detecting zone near by the bottom of the light bulb. FIG. **10**E is a pendant application with an infrared ray detection sensor built inside and an infrared ray detecting sensor installed at the bottom of a flat diffuser. Both are representative examples classified as detecting sensor installed at bottom of diffuser to form a detecting zone near by the diffuser.

As a summary of the present disclosure the key technology of the present invention involves an electronic switch using a microcontroller with program codes to receive, interpret and execute a message carrying sensing signal converted from an external control signal to control performances of lighting characteristics including light intensity and light color temperature of an LED lamp. The LED lamp

comprises a first LED lighting load featured with a high color temperature electrically connected to a first controllable switching element and a second LED lighting load featured with a low color temperature electrically connected to a second controllable switching element. The first controllable switching element and the second controllable switching element are respectively coupled with the microcontroller. The microcontroller upon receiving the message carrying sensing signal accordingly activates a corresponding subroutine to output a first control signal and a second control signal to respectively control a conduction rate of the first controllable switching device and a conduction rate of the second controllable switching element to respectively transmit electric powers to the first LED lighting load and the second LED lighting load such that a mingled color temperature thru a light diffuser and the light intensity of the LED lamp are thereby determined according to a programmed combination of conduction rates of the first controllable switching device and the second controllable switching device. A detection device serves as an interface between human and the electronic switch to convert the external control signal into the message carrying sensing signal readable and interpretable to the micro controller. The detection device is may be configured as touch less interface and direct touch interface. The touch less interface may be implemented by a wireless method to receive wireless external control signal and convert the wireless external control signal into the message carrying sensing signal readable and interpretable to the microcontroller. The wireless external control signal can be transformed from a motion signal generated with an infrared ray motion sensor, or it can be an electromagnetic wireless signal generated with a wireless receiver or transceiver, or it can be transformed from a voice signal generated with an A.I. (artificial intelligence) based device. The direct touch interface on the other hand uses a wired method to receive the external control signal set by an user, wherein the external control signal can be generated from a push button, a touch pad, a voltage divider, or a power interruption switch or button operated by the user, or a conduction rate of a phase controller set by the user, wherein, if the external control signal is an analogue signal, a conversion circuitry may be included in the detection device or as a virtual circuitry programmable embedded in the microcontroller to convert the analogue signal into the message carrying sensing signal readable and interpretable to the microcontroller.

The above-mentioned descriptions represent merely the exemplary embodiment of the present disclosure, without any intention to limit the scope of the present disclosure thereto. Various equivalent changes, alterations or modifications based on the claims of present disclosure are all consequently viewed as being embraced by the scope of the present disclosure.

What is claimed is:

1. A microcontroller based electronic switch for controlling lighting performance of an LED lamp configured with a plurality of LED lighting loads comprising:

a first controllable switching element, electrically connected between a power source and a first LED lighting load for emitting light with a first color temperature;

a second controllable switching element, electrically connected between said power source and a second LED lighting load for emitting light with a second color temperature;

at least one detection device, for detecting at least one external control signal and converting said at least one external control signal into at least one message carrying sensing signal; and

a microcontroller to receive and interpret said at least one message carrying sensing signal generated by said at least one detection device, wherein said microcontroller through a first control pin is electrically coupled to said first controllable switching element, and through a second control pin is electrically coupled to said second controllable switching element, wherein said microcontroller through at least a third control pin receives said at least one message carrying sensing signal from said at least one detection device, wherein said microcontroller controls a conduction state or a cutoff state of said first controllable switching element through said first control pin and said microcontroller controls said conduction state or said cutoff state of said second controllable switching element through said second control pin to control electric power transmission levels from said power source respectively to said first LED lighting load and to said second LED lighting load according to said at least one message carrying sensing signal generated by said at least one detection device;

wherein said first color temperature is higher than said second color temperature;

wherein said at least one message carrying sensing signal is characterized with a signal format of a short voltage signal, a long voltage signal, a plurality of short voltage signals, a plurality of long voltage signals or a combination of said short voltage signal and said long voltage signal generated in a preset time interval; wherein said short voltage signal and said long voltage signal are respectively defined either by a time length of a voltage signal or by said time length of a series of pulse signals consecutively generated; wherein when said microcontroller receives said at least one message carrying sensing signal, said microcontroller manages according to said signal format of said at least one message carrying sensing signal to perform at least one of various working modes including at least an on/off switch control mode, a dimming control mode, a color temperature tuning control mode, a color temperature switching control mode, a dimming and color temperature tuning control mode, and a delay shutoff control mode;

wherein when said first controllable switching element and said second controllable switching element are in said conduction state, said microcontroller further controls said electric power transmission levels from said power source respectively to said first LED lighting load and to said second LED lighting load according to said signal format of said at least one message carrying sensing signal received, wherein said microcontroller through said first control pin outputs a first control signal to control a conduction rate of said first controllable switching element, said microcontroller through said second control pin outputs a second control signal to control said conduction rate of said second controllable switching element;

wherein said microcontroller is an integrated circuit programmable for generating said first control signal and said second control signal, or an application specific integrated circuit (ASIC) custom made for generating said first control signal and said second control signal.

2. The microcontroller based electronic switch according to claim 1, wherein said at least one detection device is configured with a touch less interface for detecting said at least one external control signal and converting said at least one external control signal into said at least one message carrying sensing signal interpretable to said microcontroller.

3. The microcontroller based electronic switch according to claim 2, wherein said touch less interface is an active infrared ray sensor comprising an infrared ray transmitter for emitting infrared light into an area to form a defined detection zone, an infrared ray receiver for receiving infrared light reflected from an object in said defined detection zone, and a detection circuitry for detecting and generating different voltage signals in response to a motion of said object entering and leaving said defined detection zone; wherein when said object enters said defined detection zone, said detection circuitry operates to generate a first voltage sensing signal with a time length corresponding to a time interval of said object entering and staying in said defined detection zone; wherein when said object leaves said defined detection zone, said detection circuitry operates to generate a second voltage signal to conclude said time length of said first voltage sensing signal, wherein said first voltage sensing signal with said time length is a basic format for configuring said at least one message carrying sensing signal to be delivered to said microcontroller.

4. The microcontroller based electronic switch according to claim 2, wherein said touch less interface is a wireless remote control device electrically coupled to said microcontroller to receive and convert said at least one external control signal into said at least one message carrying sensing signal with said signal format interpretable to said microcontroller.

5. The microcontroller based electronic switch according to claim 4, wherein said wireless remote control device is a Wi-Fi wireless signal receiver, a Bluetooth wireless signal receiver, a Zigbee wireless signal receiver or a radio frequency wireless signal receiver.

6. The microcontroller based electronic switch according to claim 1, wherein a wireless signal transmitter is further electrically coupled with said microcontroller to convert said at least one message carrying sensing signal into a wireless control signal to control a lighting performance of at least one remote lighting apparatus.

7. The microcontroller based electronic switch according to claim 6, wherein said wireless signal transmitter is a Wi-Fi wireless signal transmitter, a Bluetooth wireless signal transmitter, a Zigbee wielded signal transmitter, or a radio frequency wireless signal transmitter.

8. The microcontroller based electronic switch according to claim 1, wherein said at least one detection device is configured with a direct touch interface for detecting and converting said at least one external control signal into said at least one message carrying sensing signal interpretable to said microcontroller.

9. The microcontroller based electronic switch according to claim 8, wherein said direct touch interface is designed with a detection circuitry operated with a push button device or a touch sensor device, wherein said detection circuitry is electrically coupled with said microcontroller, wherein when an user contacts the said direct touch interface for a time interval, said detection circuitry responsively generates a first voltage sensing signal with a time length corresponding to a time interval of said direct touch interface being contacted; when said user withdraws from said direct touch interface, said detection circuitry delivers a second voltage signal; said first voltage sensing signal with said time length is a basic format for configuring said at least one message carrying sensing signal to be delivered to said microcontroller.

10. The microcontroller based electronic switch according to claim 8, wherein said direct touch interface is a detection circuitry electrically coupled with said microcontroller to detect a signal of a short power interruption and convert said short power interruption signal into said at least one message carrying sensing signal with said signal format interpretable to said microcontroller, wherein said microcontroller accordingly activates to perform a relevant working mode.

11. The microcontroller based electronic switch according to claim 8, wherein said direct touch interface is a detection circuitry to detect a voltage signal generated by a voltage divider and to convert a voltage value of said voltage signal into said at least one message carrying sensing signal with said signal format corresponding to said voltage value generated for setting said conduction rate of said first controllable switching element and said second controllable switching element respectively.

12. The microcontroller based electronic switch according to claim 1, wherein when said microcontroller receives said at least one message carrying sensing signal, said microcontroller operates at least one working mode in response to said signal format of said at least one message carrying sensing signal.

13. The microcontroller based electronic switch according to claim 12, wherein said working mode is said on/off switch control mode, wherein when said microcontroller receives said at least one message carrying sensing signal, said microcontroller checks electric states of said first controllable switching element and said second controllable switching element , wherein if at least one of said first controllable switching element and said second controllable switching element is in conduction state, said microcontroller accordingly operates to cutoff both said first controllable switching element and said second controllable switching element, wherein if both said first controllable switching element and said second controllable switching element are in cutoff state, said microcontroller accordingly manages to conduct at least one of said first controllable switching element and said second controllable switching element.

14. The microcontroller based electronic switch according to claim 12, wherein said working mode is said delay shutoff control mode; wherein when said microcontroller receives said at least one message carrying sensing signal, said microcontroller checks the states of said first controllable switching element and said second controllable switching element, wherein if at least one of said first controllable switching element and said second controllable switching element is in conduction state, said microcontroller accordingly activates a process of delay shutoff to cutoff both said first controllable switching element and said second controllable switching element after a preset delay time; wherein upon a maturity of said preset delay time both said first controllable switching element and said second controllable switching element are instantly and simultaneously cutoff such that said LED lamp is thereby turned off; wherein if both said first controllable switching element and said second controllable switching element are in cutoff state, said microcontroller instantly and accordingly manages to conduct at least one of said first controllable switching element and said second controllable switching element.

15. The microcontroller based electronic switch according to claim 12, wherein said working mode is said dimming control mode, wherein said first control signal and said second control signal are designed to operate with an

arrangement that said conduction rate of said first controllable switching element and said conduction rate of said second controllable switching element are unidirectionally and proportionally adjusted with the same pace such that a mingled color temperature of a diffused light of said first LED lighting load and said second LED lighting load through a light diffuser is maintained at a constant level while a total light intensity of said first LED lighting load and said second LED lighting load is being proportionally adjusted according to said signal format of said at least one message carrying sensing signal.

16. The microcontroller based electronic switch according to claim **12**, wherein said working mode is said color temperature tuning control mode;

wherein said first control signal and said second control signal are designed to operate with an arrangement that said conduction rate of said first controllable switching element and said conduction rate of said second controllable switching element are reversely adjusted with the same pace such that a total light intensity of said first LED lighting load and said second LED lighting load is maintained at a constant level while a mingled color temperature of a diffused light of said first LED lighting load and said second LED lighting load thru a light diffuser is proportionately adjusted according to said signal format of said at least one message carrying sensing signal.

17. The microcontroller based electronic switch according to claim **12**, wherein said working mode is a color temperature switching control mode;

wherein said microcontroller is operated in accordance with a light color temperature switching scheme comprising at least two light color temperature performances , wherein each of said at least two light color temperature performances is respectively activated by said at least one external control signal, wherein each of said at least two light color temperature performances is further operated with a predetermined combination of conduction rates respectively for controlling said first controllable switching element and said second controllable switching element, wherein for performing each of said at least two color temperature performances, said first control signal and said second control signal are designed and predetermined to operate with an arrangement that said conduction rate of said first controllable switching element and said conduction rate of said second controllable switching element are reversely and complementarily adjusted such that the total light intensity of said first LED lighting load and said second LED lighting load is maintained at a constant level while a mingled color temperature of a diffused light of said first LED lighting load and said second LED lighting load through a light diffuser is adequately adjusted according to said predetermined combination of conduction rates for respectively controlling said first controllable switching element and said second controllable switching element.

18. The microcontroller based electronic switch according to claim **17**, wherein said at least one external control signal is a short power interruption signal generated by a power switch, a push button or a touch sensor, wherein said at least one detection device is configured with a direct touch interface comprising a detection circuitry for detecting said short power interruption signal and converting said short power interruption signal into said at least one message carrying sensing signal interpretable to said microcontroller for activating a relevant light color temperature performance in said color temperature switching scheme.

19. The microcontroller based electronic switch according to claim **17**, wherein said at least one external control signal is a voltage signal generated by at least one push button switch and at least one touch pad switch, a slide switch or a rotary switch , wherein said at least one detection device is configured with a direct touch interface comprising a circuitry for detecting said voltage signal and converting said voltage signal into said at least one message carrying sensing signal interpretable to said microcontroller for activating a relevant light color temperature performance in said color temperature switching scheme.

20. The microcontroller based electronic switch according to claim **17**, wherein said at least one external control signal is a voltage signal generated by a voltage divider, wherein said at least one detection device is configured with a direct touch interface comprising a circuitry for detecting a voltage value of said voltage signal and converting said voltage value into said at least one message carrying sensing signal interpretable to said microcontroller for activating a relevant light color temperature performance in said color temperature switching scheme.

21. The microcontroller based electronic switch according to claim **17**, wherein said at least one external control signal is an infrared light reflected from an object, wherein said at least one detection device is an active infrared ray sensor for detecting said infrared light reflected from an object and converting said infrared light reflected from an object into said at least one message carrying sensing signal interpretable to said microcontroller for activating a relevant light color temperature performance in said light color temperature switching scheme, wherein said active infrared ray sensor comprises an infrared ray transmitter for emitting infrared light into an area to form a defined detection zone, an infrared ray receiver for receiving infrared light reflected from said object in said defined detection zone, and a detection circuitry for detecting and generating different voltage signals in response to a motion of said object entering and leaving said defined detection zone; wherein when said object enters said defined detection zone, said detection circuitry operates to generate a first voltage sensing signal with a time length corresponding to a time interval of said object entering and staying in said defined detection zone; wherein when said object leaves said defined detection zone, said detection circuitry operates to generate a second voltage signal to conclude said time length of said first voltage sensing signal, wherein when said time length of said first voltage signal is shorter than a predetermined time interval, said microcontroller operates said light color temperature switching scheme to activate a relevant light color temperature performance, wherein when said time length of said first voltage signal is longer than said predetermined time interval, said microcontroller continues to reversely and complimentarily adjust said conduction rates between said first controllable switching element and said second controllable switching element till the time length of said first voltage signal ends to perform said color temperature tuning control mode.

22. The microcontroller based electronic switch according to claim **17**, wherein said at least one external control signal is a wireless external control signal, wherein said at least one detection device is wireless signal receiver to receive said wireless external control signal and convert said wireless external control signal into said at least one message carrying sensing signal interpretable to said microcontroller for

activating a relevant light color temperature performance in said light color temperature switching scheme.

23. The microcontroller based electronic switch according to claim **22**, wherein said wireless signal receiver is a Wi-Fi wireless signal receiver, a Bluetooth wireless signal receiver, a Zigbee wireless signal receiver or a radio frequency wireless signal receiver.

24. The microcontroller based electronic switch according to claim **12**, wherein said working mode is said dimming and color temperature tuning control mode; wherein said first control signal and said second control signal are designed to operate with an arrangement that said conduction rate of said first controllable switching element is reduced at a faster pace than said conduction rate of said second controllable switching element being reduced such that a mingled color temperature of a diffused light of said first LED lighting load and said second LED lighting load thru a light diffuser continues to change to a warmer illumination along with a continuous reduction of light intensity, wherein during a cycle of said dimming and color temperature tuning control mode, said light intensity and said mingled color temperature of said first LED lighting load and said second LED lighting load are determined by said signal format of said at least one message carrying sensing signal received from said detection device.

25. The microcontroller based electronic switch according to claim **12**, wherein said working mode is said dimming and color temperature tuning control mode, wherein said first control signal and said second control signal are designed with an arrangement that said conduction rate of said first controllable switching element is proportionately decreased according to said signal format of said at least one message carrying sensing signal while said conduction rate of said second controllable switching element is maintained at constant level till being turned off to create a dim to warm effect, wherein during a cycle of said dimming and color temperature tuning control mode, a light intensity and a mingled color temperature of a diffused light of said first LED load and said second LED load thru a light diffuser are determined by said signal format of said at least one message carrying sensing signal received from said at least one detection device.

26. The microcontroller based electronic switch according to claim **12**, wherein said working mode is said color temperature tuning control mode, wherein when said microcontroller receives a first said at least one message carrying sensing signal, said microcontroller operates to activate a free running process to perform an automatic color temperature tuning cycle, wherein said first control signal and said second control signal are designed to operate with an arrangement that said conduction rate of said first controllable switching element and said conduction rate of said second controllable switching element are continuously and reversely changed with the same pace such that the total light intensity of said first LED lighting load and said second LED lighting load is maintained at a constant level while a mingled color temperature of a diffused light of said first LED lighting load and said second LED lighting load thru a light diffuser is continuously and proportionately changed from a higher color temperature to a lower color temperature or from a lower color temperature to a higher temperature, wherein when said microcontroller receives a second said at least one message carrying sensing signal during said automatic color temperature tuning cycle, said microcontroller operates to terminate said free running process with said mingled color temperature being thereby determined and memorized for repetitive performance.

27. The microcontroller based electronic switch according to claim **12**, wherein said working mode is said dimming and color temperature tuning control mode, wherein when said microcontroller receives said at least one message carrying sensing signal with a relevant said signal format, said microcontroller operates to activate a relevant process to successively and respectively change conduction rates of said first switching element and said second switching element from maximum conduction rates to minimum conduction rates, and continuously from the minimum conduction rates to the maximum conduction rates to complete a dimming and color temperature tuning cycle, wherein a moment at which said at least one message carrying sensing signal ceases during said dimming and color temperature tuning cycle, a total light intensity and a mingled color temperature of a diffused light of said first LED lighting load and said second LED lighting load through a light diffuser are thereby determined and memorized for repetitive performance.

28. The microcontroller based electronic switch according to claim **27**, wherein during a first half cycle period of said dimming and color temperature tuning cycle said first control signal and said second control signal are designed to operate with an arrangement that said conduction rate of said first controllable switching element is decreased at a faster pace than said conduction rate of said second controllable switching element being decreased such that said first controllable switching element leads said second controllable switching element in both decreasing said conduction rate and reaching a cutoff state during said first half cycle period of said dimming and color temperature tuning cycle to create a dim to warm effect; wherein during a second half cycle period of said dimming and color temperature cycle said conduction rate of said first controllable switching element is increased at a faster pace than said conduction rate of said second controllable switching element being increased with a time phase delay such that both said first controllable switching element and said second controllable switching element simultaneously reach a full conduction state at the end of full cycle period of said dimming and color temperature tuning cycle to create a brighten to cold effect, wherein at any time during a full cycle of said dimming and color temperature tuning mode, a total light intensity and a mingled color temperature of a diffused light of said first LED lighting load and said second LED lighting load thru the light diffuser are determined by said signal format of said at least one message carrying sensing signal received from said at least one detection device.

29. The microcontroller based electronic switch according to claim **12**, wherein said working mode is said delay shutoff control mode; wherein when said microcontroller receives said message carrying sensing signal, said microcontroller checks the states of said first controllable switching element and said second controllable switching element, wherein if at least one of said first controllable switching element and said second controllable switching element is in conduction state, said microcontroller accordingly activates a process of delay shutoff to completely cutoff both said first controllable switching element and said second controllable switching element after a preset delay time; wherein during said preset delay time said microcontroller manages to gradually reduce the conduction rates of said first controllable switching element and said second controllable switching element with the same pace till both said first controllable switching element and said second controllable switching element are completely cut off at the end of said preset delay time such that said first LED lighting load and said second LED

lighting of said LED lamp are slowly dimmed to zero with the same pace such that said LED lamp is slowly turned off with color temperature unchanged, wherein if both said first controllable switching element and said second controllable switching element are in cutoff state, said microcontroller instantly and accordingly manages to conduct at least one of said first controllable switching element and said second controllable switching element.

30. The microcontroller based electronic switch according to claim **12**, wherein said working mode is said delay shutoff control mode; wherein when said microcontroller receives said message carrying sensing signal, said microcontroller checks the states of said first controllable switching element and said second controllable switching element, wherein if at least one of said first controllable switching element and said second controllable switching element is in conduction state, said microcontroller accordingly activates a process of delay shutoff to cutoff both said first controllable switching element and said second controllable switching element after a preset delay time; wherein during said preset delay time said microcontroller manages to instantly, proportionally and respectively reduce conduction rates of said first controllable switching element and said second controllable switching element to lower levels for a shorter time interval, wherein upon a maturity of said shorter time interval said microcontroller further manages to gradually reduce conduction rates of said first controllable switching element and said second controllable switching element with the same pace till said first controllable switching element and said second controllable switching element are both cut off at the end of said preset delay time such that said first LED lighting load and said second LED lighting load are both dimmed with the same pace such that LED lamp is slowly turned off with color temperature unchanged, wherein if both said first controllable switching element and said second controllable switching element are in cutoff state, said microcontroller instantly and accordingly manages to conduct at least one of said first controllable switching element and said second controllable switching element.

31. A microcontroller based electronic switch for controlling lighting performance of an LED lamp configured with a plurality of LED lighting loads comprising:

- a first controllable switching element, electrically connected between a first LED lighting load for emitting light with a first color temperature and a power source;
- a second controllable switching element, electrically connected between a second LED lighting load for emitting light with a second color temperature and said power source;
- a first detection device for detecting a first external control signal and converting said first external control signal into a first message carrying sensing signal;
- a second detection device for detecting a second external control signal and converting said second external control signal into a second message carrying sensing signal; and
- a microcontroller through a first control pin receives said first message carrying sensing signal generated by said first detection device, said microcontroller through a second control pin receives said second message carrying sensing signal generated by said second detection device, wherein said microcontroller through a third control pin is electrically coupled to said first controllable switching element, wherein said microcontroller through a fourth control pin is electrically coupled to said second controllable switching element, wherein said microcontroller respectively controls conduction state or cutoff state of said first controllable switching element and said second controllable switching element to control electric power transmissions from said power source respectively to said first LED lighting load and to said second LED lighting load according to said first message carrying sensing signal and said second message carrying sensing signal generated respectively by said first detection device and said second detection device;
- wherein said first color temperature is higher than said second color temperature;
- wherein said first detection device is a touch less interface to receive and convert said first external control signal into said first message carrying sensing signal interpretable to said microcontroller;
- wherein said second detection device is a direct touch interface to receive and convert said second external control signal into said second message carrying sending signal interpretable to said microcontroller;
- wherein said first message carrying sensing signal and said second message carrying sensing signal are characterized with a signal format of a short voltage signal, a long voltage signal, a plurality of short voltage signals, a plurality of voltage signals or a combination of said short voltage signal and said long voltage signal generated in a preset time interval;
- wherein the short voltage signal and the long voltage signal are respectively defined either by a time length of a voltage signal or by the time length of a series of pulse signals consecutively generated; wherein when said microcontroller receives said first message carrying sensing signal or said second message carrying sensing signal, said microcontroller manages according to said signal format of said first message carrying sensing signal or said second message carrying sensing signal to perform at least one of various working modes including at least an on/off switch control mode, a dimming control mode, a color temperature tuning control mode, a dimming and color temperature tuning control mode, and a delay shutoff control mode;
- wherein when said first controllable switching element and said second controllable switching element are in conduction state, said microcontroller further controls electric power transmission levels from said power source respectively to said first LED lighting load and to said second LED lighting load according to said signal format of said first message carrying sensing signal or said second message carrying sensing signal received, wherein said microcontroller through said third control pin outputs a first control signal to control a conduction rate of said first controllable switching element, said microcontroller through said fourth control pin outputs a second control signal to control said conduction rate of said second controllable switching element;
- wherein said microcontroller is an integrated circuit programmable for generating said first control signal and said second control signal, or an application specific integrated circuit (ASIC) custom made for generating said first control signal and said second control signal.

32. The microcontroller based electronic switch according to claim **31**, wherein said touch less interface is an active infrared ray sensor comprising an infrared ray transmitter for emitting infrared light into an area to form a defined detection zone, an infrared ray receiver for receiving infrared light reflected from an object in said defined detection zone, and a detection circuitry for detecting and generating different

voltage signals in response to a motion of said object entering and leaving said defined detection zone; wherein when said object enters said defined detection zone, said detection circuitry operates to generate a first voltage sensing signal with a time length corresponding to a time interval of said object entering and staying in said defined detection zone; wherein when said object leaves said defined detection zone, said detection circuitry operates to generate a second voltage signal to conclude said time length of said first voltage sensing signal, wherein said first voltage sensing signal with said time length is a basic format for configuring said first message carrying sensing signal to be delivered to said microcontroller.

33. The microcontroller based electronic switch according to claim **31**, wherein said touch less interface of said first detection device is a wireless remote control device electrically coupled to said microcontroller to receive and convert a wireless external control signal into said first message carrying sensing signal with said signal format interpretable to said microcontroller.

34. The microcontroller based electronic switch according to claim **33**, wherein the wireless remote control device is a Wi-Fi wireless signal receiver, a Bluetooth wireless signal receiver, a Zigbee wireless signal receiver or a radio frequency wireless signal receiver.

35. The microcontroller based electronic switch according to claim **31**, wherein said direct touch interface of said second detection device is a detection circuitry operated with a push button or a touch sensor, wherein said detection circuitry is electrically coupled with said microcontroller, wherein when an user contacts said direct touch interface for a time interval, said detection circuitry responsively generates a first voltage signal with a time length corresponding to said time interval of said direct touch interface being contacted wherein when said user withdraws from said direct touch interface, said second detection device delivers a second voltage signal; said first voltage signal with said time length is a basic format for configuring said second message carrying sensing signal to be delivered to said microcontroller.

36. The microcontroller based electronic switch according to claim **31**, wherein said direct touch interface of said second detection device is a detection circuitry electrically coupled with said microcontroller to detect a signal of a short power interruption and convert said short power interruption signal into said second message carrying sensing signal with said signal format interpretable to said microcontroller for performing various working modes.

37. The microcontroller based electronic switch according to claim **31**, wherein said direct touch interface of said second detection device is a circuitry to detect a voltage signal generated by a voltage divider and to convert a voltage value of said voltage signal into said second message carrying sensing signal with said signal format corresponding to said voltage value for controlling and setting said conduction rate of said first controllable switching element and said conduction rate of said second controllable switching element respectively.

38. The microcontroller based electronic switch according to claim **31**, wherein a wireless signal transmitter is further electrically coupled with said microcontroller to convert said first message carrying sensing signal or said second message carrying sensing signal into a wireless control signal to control a lighting performance of at least one remote lighting apparatus.

39. The microcontroller based electronic switch according to claim **38**, wherein said wireless signal transmitter is a Wi-Fi wireless signal transmitter, a Bluetooth wireless signal transmitter, a Zigbee wireless signal transmitter, or a radio frequency wireless signal transmitter.

40. A lighting apparatus comprising:

a first LED lighting load for emitting light with a first color temperature;

a second LED lighting load for emitting light with a second color temperature;

a diffuser, covering said first LED lighting load and said second LED lighting load to create a diffused light with a mingled color temperature; and

a microcontroller based electronic switch electrically connected to said first LED lighting load and to said second LED lighting load, said microcontroller based electronic switch further comprising:

a first switching element, electrically connected between said first LED lighting load and a power source;

a second switching element, electrically connected between said second LED lighting load and said power source;

at least a detection device, for detecting at least one external control signal and converting said at least one external control signal into at least one message carrying sensing signal;

a microcontroller to receive and interpret said at least one message carrying sensing signal generated by said at least one detection device, wherein said microcontroller through a first control pin is electrically coupled to said first switching element, and through a second control pin is electrically coupled to said second switching element, wherein said microcontroller through a third control pin receives said at least one message carrying sensing signal from said at least one detection device, wherein said microcontroller controls a conduction state or a cutoff state of said first switching element through said first control pin and said microcontroller controls said conduction state or said cutoff state of said second switching element through said second control pin to control electric power transmission levels from said power source respectively to said first LED lighting load and to said second LED lighting load according to said at least one message carrying sensing signal generated by said at least one detection device;

wherein said first color temperature is higher than said second color temperature;

wherein said at least one message carrying sensing signal is characterized with a signal format of a short voltage signal, a long voltage signal, a plurality of short voltage signals, a plurality of long voltage signals or a combination of short voltage signal and long voltage signal generated in a preset time interval; wherein said short voltage signal and said long voltage signal are respectively defined either by a time length of a voltage signal or by said-time length of a series of pulse signals consecutively generated; wherein when said microcontroller receives said at least one message carrying sensing signal, said microcontroller operates according to said signal format of said at least one message carrying sensing signal to perform at least one of various working modes including at least an on/off switch control mode, a dimming control mode, a color temperature tuning control mode, a color temperature switching mode, a dimming and color temperature tuning control mode, and a delay shutoff control mode;

wherein when said first switching element and said second switching element are in said conduction state, said

microcontroller further controls said electric power transmission levels from said power source respectively to said first LED lighting load and to said second LED lighting load according to said signal format of said at least one message carrying sensing signal received, wherein said microcontroller through said first control pin outputs a first control signal to change a conduction rate of said first switching element, said microcontroller through said second control pin outputs a second control signal to change said conduction rate of said second switching element;

wherein said microcontroller is an integrated circuit programmable for generating said first control signal and said second control signal, or an application specific integrated circuit (ASIC) custom made for generating said first control signal and said second control signal.

41. The lighting apparatus according to claim **40**, wherein both said first switching element and said second switching element are controllable switching element, wherein when said microcontroller receives said at least one message carrying sensing signal, said microcontroller operates to output said first control signal and said second control signal with an arrangement that said conduction rate of said first switching element and said conduction rate of said second switching element are reversely adjusted with the same pace such that a total electric power transmitted to said first LED lighting load and said second LED lighting load is maintained at a constant level while said mingled color temperature of said lighting apparatus is proportionately adjusted according to said signal format of said at least one message carrying sensing signal to perform said color temperature tuning control mode.

42. The lighting apparatus according to claim **40**, wherein both said first switching element and said second switching element are controllable switching elements, wherein said first control signal and said second control signal are designed to operate with an arrangement that said conduction rate of said first switching element and said conduction rate of said second switching element are unidirectionally and proportionally adjusted with the same pace such that said mingled color temperature of said lighting apparatus is maintained at a constant level while a light intensity of said lighting apparatus is being proportionately adjusted according to said signal format of said at least one message carrying sensing signal to perform said dimming control mode.

43. The lighting apparatus according to claim **40**, wherein at least said first switching element is a controllable switching element, wherein when said dimming and color temperature tuning control mode is performed, said microcontroller manages to output said first control signal to proportionately reduce said conduction rate of said first switching element such that said first LED lighting load with said first color temperature is dimmed according to said signal format of said at least one message carrying sensing signal, wherein said microcontroller manages to output said second control signal to control said conduction rate of said second switching element such that said second LED lighting load with said second color temperature operates at a constant power level before being turned off to create a dim to warm effect, wherein during a cycle of said dimming and color temperature tuning control mode, a light intensity and said mingled color temperature of said lighting apparatus are determined by said signal format of said at least one message carrying sensing signal received from said at least one detection device.

44. The lighting apparatus according to claim **40**, wherein said first switching element and said second switching element are controllable switching elements, wherein when said dimming and color temperature tuning control mode is performed, said microcontroller outputs said first control signal to control a conduction rate of said first switching element, said microcontroller outputs said second control signal to control said conduction rate of said second switching element, wherein said first control signal and said second control signal are designed to operate with an arrangement that said first LED lighting load and said second LED lighting load are respectively dimmed in such a way that said first LED lighting load leads said second LED lighting load in reaching a turnoff state in performing said dimming and color temperature tuning control mode such that said mingled color temperature created by said diffuser of said lighting apparatus continues to change to a warmer illumination along with a continuous reduction of light intensity according to said signal format of said at least one message carrying sensing signal, wherein during a cycle of said dimming and color temperature tuning control mode, a light intensity and said mingled color temperature of said lighting apparatus are determined by said signal format of said at least one message carrying sensing signal received from said at least one detection device.

45. The lighting apparatus according to claim **40**, wherein said first LED lighting load is configured with a plurality of light emitting diodes and said second LED lighting load is configured with a plurality of light emitting diodes , wherein said first switching element comprises a plurality of transistors with each transistor electrically coupled to at least one of the plurality of light emitting diodes of said first LED lighting load, wherein said conduction rate of said first switching element is adjustable thru outputting at least one control signal to respectively control conduction or cutoff of at least one said transistor selected, wherein when said dimming and color temperature tuning control mode is performed, said microcontroller successively outputs said at least one control signal to decreasingly change said conduction rate of said first switching element such that said first LED lighting load with said first color temperature is turned off gradually, wherein said microcontroller successively output said at least one control signal to manage said conduction rate of said second switching element such that said second LED lighting load with said second color temperature operates at a constant electric power level before being turned off to create a dim to warm effect, wherein during a cycle of said dimming and color temperature tuning mode, a light intensity and said mingled color temperature of said lighting apparatus are determined by said signal format of said at least one message carrying sensing signal received from said at least one detection device.

46. The lighting apparatus according to claim **40**, wherein said at least one detection device is a touch less interface for detecting said at least one external control signal and converting said at least one external control signal into said at least one message carrying sensing signal interpretable to said microcontroller.

47. The lighting apparatus according to claim **46**, wherein said touch less interface is an active infrared ray sensor comprising an infrared ray transmitter for emitting infrared light into an area to form a defined detection zone, an infrared ray receiver for receiving infrared light reflected from an object in said defined detection zone, and a detection circuitry for detecting and generating different voltage signals in response to a motion of said object entering and

leaving said defined detection zone; wherein when said object enters said defined detection zone, said detection circuitry operates to generate a first voltage sensing signal with a time length corresponding to a time interval of said object entering and staying in said defined detection zone; wherein when said object leaves said defined detection zone, said detection circuitry operates to generate a second voltage signal to conclude said time length of said first voltage sensing signal, wherein said first voltage sensing signal with said time length is a basic format for configuring said at least one message carrying sensing signal to be delivered to said microcontroller.

48. The lighting apparatus according to claim **47**, wherein said lighting apparatus is an LED light bulb constructed with said microcontroller based electronic switch, and said at least one detection device is said active infrared ray sensor being mounted in or on said LED bulb housing for detecting said at least one external control signal.

49. The lighting apparatus according to claim **46**, wherein said touch less interface is a wireless remote control device electrically coupled to said microcontroller to receive and convert at least one external control signal into said at least one message carrying sensing signal with said signal format interpretable to said microcontroller.

50. The lighting apparatus according to claim **49**, wherein said wireless remote control device is a Wi-Fi wireless signal receiver, a Bluetooth wireless signal receiver, a Zigbee wireless signal receiver or a radio frequency wireless signal receiver.

51. The lighting apparatus according to claim **40**, wherein a wireless signal transmitter is further electrically coupled with said microcontroller to convert said at least one message carrying sensing signal into at least one wireless control signal to control a lighting performance of at least one remote lighting apparatus.

52. The lighting apparatus according to claim **51**, wherein said wireless signal transmitter is a Wi-Fi wireless signal transmitter, a Bluetooth wireless signal transmitter, a Zigbee wireless signal transmitter, or a radio frequency wireless signal transmitter.

53. The lighting apparatus according to claim **40**, wherein said at least one detection device is a direct touch interface for detecting said at least one external control signal and converting said at least one external control signal into said at least one message carrying sensing signal interpretable to said microcontroller.

54. The lighting apparatus according to claim **53**, wherein said direct touch interface is a detection circuitry operated with a push button device or a touch sensor device, wherein when an user contacts said direct touch interface for a time interval, said detection circuitry responsively generates a first voltage signal with a time length corresponding to said time interval of said direct touch interface being contacted; wherein when said user withdraws from said direct touch interface, said detection circuitry delivers a second voltage signal; said first voltage signal with said time length is a basic format for configuring said at least one message carrying sensing signal to be delivered to said microcontroller.

55. The lighting apparatus according to claim **53**, wherein said direct touch interface is a detection circuitry electrically coupled with said microcontroller to detect a signal of a short power interruption and convert said short power interruption signal into said at least one message carrying sensing signal interpretable to said microcontroller for performing various working modes.

56. The lighting apparatus according to claim **53**, wherein said direct touch interface is a circuitry to detect a voltage signal generated by a voltage divider and convert a voltage value of said voltage signal into said at least one message carrying sensing signal with said signal format corresponding to said voltage value-generated for setting conduction rates of said first switching element and said second switching element respectively.

57. A lighting apparatus comprising:

a first LED lighting load for emitting light with a first color temperature;

a second LED lighting load for emitting light with a second color temperature;

a third LED lighting load for emitting light with a third color temperature;

a diffuser, covering said first LED lighting load, said second LED lighting load and said third LED lighting load to create a diffused light with a mingled color temperature;

a microcontroller based electronic switch electrically connected to said first LED lighting load, said second LED lighting load and said third LED lighting load, said microcontroller based electronic switch further comprising:

a first controllable switching element, electrically connected between said first LED lighting load and a power source;

a second controllable switching element, electrically connected between said second LED lighting load and the power source;

a third controllable switching element, electrically connected between said third LED lighting load and the power source;

at least one detection device, for detecting at least one external control signal and converting said at least one external control signal into at least one message carrying sensing signal; and

a microcontroller to receive and interpret said at least one message carrying sensing signal generated by said at least one detection device, wherein said microcontroller through a first control pin is electrically coupled to said first controllable switching element, said microcontroller through a second control pin is electrically coupled to said second controllable switching element, and said microcontroller through a third control pin is electrically coupled to said third controllable switching element; wherein said microcontroller through a fourth control pin receives said at least one message carrying sensing signal from said at least one detection device, wherein said microcontroller controls a conduction state or a cutoff state of said first controllable switching element through said first control pin, said microcontroller controls said conduction state or said cutoff state of said second controllable switching element through said second control pin, and said microcontroller controls the said conduction state or said cutoff state of said third controllable switching element through said third control pin to control electric power transmission levels from said power source respectively to said first LED lighting load, to said second LED lighting load and to said third LED lighting load according to said at least one message carrying sensing signal generated by said at least one detection device;

wherein said first color temperature is higher than said second color temperature and said second color temperature is higher than said third color temperature;

wherein said at least one message carrying sensing signal is characterized with a signal format of a short voltage signal, a long voltage signal, a plurality of short voltage signals, a plurality of long signals or a combination of said short voltage signal and said long voltage signal generated in a preset time interval; wherein said short voltage signal and said long voltage signal are respectively defined either by a time length of a voltage signal or by said time length of a voltage signal comprising a series of pulse signals consecutively generated; wherein when said microcontroller receives said at least one message carrying sensing signal, said microcontroller operates according to said signal format of said at least one message carrying sensing signal to perform at least one of various working modes including at least an on/off switch control mode, a dimming control mode, a color temperature tuning control mode, a dimming and color temperature tuning control mode and a delay shutoff control mode;

wherein when said first controllable switching element, said second controllable switching element and said third controllable switching element are in said conduction state, said microcontroller further controls said electric power transmission levels from the power source respectively to said first LED lighting load, to said second LED lighting load and to said third LED lighting load according to said signal format of said at least one message carrying sensing signal received, wherein said microcontroller through said first control pin outputs a first control signal to change conduction rate of said first controllable switching element, said microcontroller through said second control pin outputs a second control signal to change conduction rate of said second controllable switching element and said microcontroller through said third control pin outputs a third control signal to change conduction rate of said third controllable switching element;

wherein when said microcontroller receives said at least one message carrying sensing signal said signal format for performing said dimming and color temperature tuning control mode, said microcontroller manages to output different control signals to said first controllable switching element, to said second controllable switching element and to said third controllable switching element with an arrangement that said first LED lighting load leads said second LED lighting load and said second LED lighting load leads said third LED lighting load in reaching a turnoff state such that said mingled color temperature of said lighting apparatus continues to change to a warmer illumination along with a continuous reduction of light intensity according to said signal format of said at least one message carrying sensing signal, wherein during a cycle of said dimming and color temperature tuning control mode, a light intensity and said mingled color temperatures of the lighting apparatus are determined by said signal format of said at least one message carrying sensing signal received from said at least one detection device;

wherein said microcontroller is an integrated circuit programmable for generating said first control signal, said second control signal and said third control signal, or an application specific integrated circuit (ASIC) custom made for generating said first control signal, said second control signal and said third control signal.

58. The lighting apparatus according to claim **57**, wherein said at least one detection device is configured with a touch less interface for detecting said at least one external control signal and converting said at least one external control signal into said at least one message carrying sensing signal interpretable to said microcontroller.

59. The lighting apparatus according to claim **58**, wherein said touch less interface is an active infrared ray sensor comprising an infrared ray transmitter for emitting infrared light into an area to form a defined detection zone, an infrared ray receiver for receiving infrared light reflected from an object in said defined detection zone, and a detection circuitry for detecting and generating different voltage signals in response to a motion of said object entering and leaving said defined detection zone; wherein when said object enters said defined detection zone, said detection circuitry operates to generate a first voltage sensing signal with a time length corresponding to a time interval of said object entering and staying in said defined detection zone; wherein when said object leaves said defined detection zone, said detection circuitry operates to generate a second voltage signal to conclude said time length of said first voltage sensing signal, wherein said first voltage sensing signal with said time length is a basic format for configuring said at least one message carrying sensing signal to be delivered to said microcontroller.

60. The lighting apparatus according to claim **59**, wherein said lighting apparatus is a LED light bulb constructed with said microcontroller based electronic switch, and said at least one detection device is said active infrared ray sensor being mounted in or on said LED bulb housing for detecting said at least one external control signal.

61. The lighting apparatus according to claim **58**, wherein said touch less interface is a wireless remote control device electrically coupled to said microcontroller to receive and convert said at least one external control signal into said at least one message carrying sensing signal with said signal format interpretable to said microcontroller.

62. The lighting apparatus according to claim **61**, wherein said wireless remote control device is a Wi-Fi wireless signal receiver, a Bluetooth wireless signal receiver, a Zigbee wireless signal receiver or a radio frequency wireless signal receiver.

63. The lighting apparatus according to claim **57**, wherein a wireless signal transmitter is further electrically coupled with said microcontroller to convert said at least one message carrying sensing signal into a wireless control signal to control a lighting performance of at least one remote lighting apparatus.

64. The lighting apparatus according to claim **63**, wherein said wireless signal transmitter is a Wi-Fi wireless signal transmitter, a Bluetooth wireless signal transmitter, a Zigbee wireless signal transmitter, or a radio frequency wireless signal transmitter.

65. The lighting apparatus according to claim **57**, wherein said detection device is configured with a direct touch interface for detecting said at least one external control signal and converting said at least one external control signal into said at least one message carrying sensing signal interpretable to said microcontroller.

66. The lighting apparatus according to claim **65**, wherein said direct touch interface is a detection circuitry operated with a push button device or a touch sensor device, wherein said detection circuitry is electrically coupled with said microcontroller, wherein when an user contacts said direct touch interface for a time interval, said detection circuitry responsively generates a first voltage signal with a time length corresponding to said time interval of said direct touch interface being contacted; wherein when said user withdraws from said direct touch interface, said detection

circuitry delivers a second voltage signal; said first voltage signal with said time length is a basic format for configuring said at least one message carrying sensing signal to be delivered to said microcontroller.

67. The lighting apparatus according to claim **65**, wherein said direct touch interface is a detection circuitry electrically coupled with said microcontroller to detect a signal of a short power interruption and convert said short power interruption signal into said at least one message carrying sensing signal interpretable to said microcontroller for performing various working modes.

68. The lighting apparatus according to claim **65**, wherein said direct touch interface is a circuitry to detect a voltage signal generated by a voltage divider and to convert a voltage value of said voltage signal into said at least one message carrying sensing signal with said signal format corresponding to said voltage value generated for setting conduction rates of said first switching element and said second switching element respectively.

69. A method of creating a dim to warm effect for controlling lighting performance of an LED lamp comprising:

using at least a first LED lighting load with a high color temperature and a second LED lighting load with a low color temperature to form a lighting unit of said LED lamp;

electrically coupling a switching circuitry to said first LED lighting load and to said second LED lighting load to respectively deliver different average electric powers to said first LED lighting load and to said second LED lighting load for generating different illuminations respectively ;

using a detection device to detect an external control signal and to convert said external control signal into a message carrying sensing signal with a time length;

using a microcontroller to output at least one control signal to control a conduction rate of said switching circuitry electrically coupled to said first LED lighting load and to said second LED lighting load according to said time length of said message carrying sensing signal received from said detection device; and

using a diffuser to cover at least said first LED lighting load with said high color temperature and said second LED lighting load with said low color temperature to create a diffused light with a mingled color temperature;

wherein said switching circuitry comprises at least one semiconductor switching device; wherein when a dimming cycle is performed, said microcontroller receives said message carrying sensing signal and responsively outputs said at least one control signal to reduce conduction rate of said switching circuitry coupled to said first LED lighting load and to said second LED lighting load with an arrangement that said first LED lighting load with said high color temperature leads said second LED lighting load with said low color temperature in reaching a turnoff state during said dimming cycle such that said mingled color temperature of said LED lamp continues to change to a warmer illumination along with a continuous reduction of light intensity according to said time length of said message carrying sensing signal to create a dim to warm effect; wherein at any time during said dimming cycle a light intensity and said mingled color temperature of said lighting apparatus are determined by said time length of said message carrying sensing signal received from said detection device;

wherein said microcontroller is an integrated circuit programmable for generating said at least one control signal, or an application specific integrated circuit (ASIC) custom made for generating said at least one control signal.

70. The method of creating a dim to warm effect for controlling lighting performance of an LED lamp according to claim **69**, wherein during said dimming cycle said switching circuitry manages to continually reduce said average electrical power delivered to said first LED lighting load and said switching circuitry simultaneously manages to deliver a constant said average electric power to said second LED lighting load till at a time when said first LED lighting load is turned off and then said switching circuitry manages to reduce said average electric power to said second LED lighting load till said second LED lighting load is also turned off completely, such that said first LED lighting load leads said second LED lighting load in reaching a turnoff state before the end of said dimming cycle.

71. The method of creating a dim to warm effect for controlling lighting performance. of an LED lamp according to claim **69**, wherein during said dimming cycle said switching circuitry manages to continuously reduce said average electric power delivered to said first LED lighting load at a faster pace than reducing said average electric power delivered to said second LED lighting load such that said first LED lighting load leads said second LED lighting load in reaching a turnoff state in performing said dimming cycle to create a dim to warm effect through a light diffuser according to said time length of said message carrying sensing signal, wherein at any time during said dimming cycle, a light intensity and said mingled color temperature of said LED lamp are determined by said time length of said message carrying sensing signal received from said detection device.

72. The method of creating a dim to warm effect for controlling lighting performance of an LED lamp according to claim **69**, wherein during said dimming cycle, said switching circuitry manages to continuously reduce said average electric power delivered to said first LED lighting load at a faster pace such that said first LED lighting load leads said second LED lighting load in reaching a turnoff state during said dimming cycle, wherein in order to accelerate color temperature tuning pace along with a continuous reduction of light intensity of said LED lamp, said switching circuitry initially manages to increase said average electric power delivered to said second LED lighting load with a pace slower than the reduction pace of said average electric power delivered to said first LED lighting load such that a total average electric power delivered to said first LED lighting load and said second LED lighting load continues to decline while said mingled color temperature of said LED lamp continues to change to a warmer illumination at a faster pace to perform a faster dim to warm process, wherein when a dim to warm process ceases at a time point when said first LED lighting load reaches a turnoff state is an inflection time point for said switching circuitry to reversely manage to decrease said average electric power delivered to said second LED lighting load till reaching said turnoff state at the ending point of said dimming cycle, such that the dimming of said LED lamp continues to perform with said low color temperature of said second LED lighting load thru the end of said dimming cycle to complete a full cycle of said dim to warm process, wherein at any time during said dimming cycle , said light intensity and said mingled color tempera-

ture of said LED lamp are determined by said time length of said message carrying sensing signal received from said detection device.

73. A lighting apparatus comprising:

a first LED lighting load for emitting light with a first color temperature;

a second LED lighting load for emitting light with a second color temperature;

a diffuser, covering said first LED lighting load and said second LED lighting load to create a diffused light with a mingled color temperature; and

a microcontroller based electronic switch, electrically coupled to said first LED lighting load and said second LED lighting load, wherein said microcontroller based electronic switch further comprising:

a first controllable switching element, electrically coupled between said first LED lighting load and a power source;

a second controllable switching element , electrically coupled between said second LED lighting load and the power source;

a first detection device for detecting a first external control signal and converting said first external control signal into a first message carrying sensing signal;

a second detection device for detecting a second external control signal and converting said second external control signal into a second message carrying sensing signal; and

a microcontroller to receive and interpret said first message carrying sensing signal and said second message carrying sensing signal to respectively activate a corresponding process for controlling and setting a light intensity level and a mingled color temperature level of said lighting apparatus;

wherein said microcontroller through a first control pin is electrically coupled to said first controllable switching element and through a second control pin is electrically coupled to said second controllable switching element, wherein said microcontroller through a third control pin receives said first message carrying sensing signal from said first detection device, wherein said microcontroller through a fourth control pin receives said second message carrying sensing signal from said second detection device;

wherein said color temperature of said first LED lighting load is higher than said color temperature of said second LED lighting load;

wherein said first message carrying sensing signal and said second message carrying sensing signal are characterized with a signal format of a short voltage signal, a long voltage signal or a plurality of short voltage signals generated in a preset time interval; wherein the short voltage signal and the long voltage signal are respectively defined either by a time length of a voltage signal or by the time length of a voltage signal comprising a series of pulse signals consecutively generated;

wherein said first detection device is a first direct touch interface designed to detect said first external control signal and convert said first external control signal into said first message carrying sensing signal interpretable to said microcontroller for controlling and setting said mingled color temperature level of said lighting apparatus;

wherein when said microcontroller receives said first message carrying sensing signal from said first detection device, said microcontroller manages to activate a first process to output a first control signal to reduce conduction rate of said first controllable switching element and meantime to output a second control signal to increase said conduction rate of said second controllable switching element, or vice versa, according to said signal format of said first message carrying sensing signal with an arrangement that a total power delivered to said first LED lighting load and said second LED lighting load remains unchanged;

wherein said second detection device is a second direct touch interface designed to detect a second external control signal and convert said second external control signal into said second message carrying sensing signal interpretable to said microcontroller for controlling and setting said light intensity level of said lighting apparatus;

wherein when said microcontroller receives said second message carrying sensing signal from said second detection device, said microcontroller manages further to determine a total power level transmitted to said first LED lighting load and said second LED lighting load according to said signal format of said second message carrying sensing signal with an arrangement that the ratio between the power delivered to said first LED lighting load and a power delivered to said second LED lighting load remains at a constant level; wherein said microcontroller outputs a third control signal to reduce conduction rate of said first controllable switching element and meantime to output a fourth control signal to reduce conduction rate of said second controllable switching element with the same pace, or vice versa, such that said mingled color temperature of said diffused light through said diffuser remains unchanged.

74. The lighting apparatus according to claim **73**, wherein a power switch is used to control on state and off state of said lighting apparatus; wherein when said power switch is turned on said lighting apparatus responsively perform an illumination and wherein when said power switch is turned off the illumination of said lighting apparatus is immediately shutoff.

75. The lighting apparatus according to claim **73**, wherein a third detection device is further installed and coupled to a control pin of said microcontroller to detect a voltage signal generated by a third direct touch interface and convert said voltage signal into a third message carrying sensing signal for controlling an on/off performance of said lighting apparatus; wherein when said microcontroller receives said third message carrying sensing signal, said microcontroller operates to turn on or turn off said lighting apparatus alternatively.

76. The lighting apparatus according to claim **73**, wherein said first direct touch interface of said first detection device comprises a circuitry to detect a voltage signal generated by a voltage divider and convert a voltage value of said voltage signal into said first message carrying sensing signal.

77. The lighting apparatus according to claim **73**, wherein said second direct touch interface of said second detection device comprises a circuitry to detect a voltage signal generated by a voltage divider and convert a voltage value of said voltage signal into said second message carrying sensing signal.

78. The lighting apparatus according to claim **73**, wherein said first direct touch interface of said first detection device comprise a circuitry to detect a voltage signal generated by a push button interface or a touch pad interface, and convert said voltage signal into said first message carrying sensing signal with a time length corresponding to a time interval of

said push button interface or said touch pad interface being continuously contacted by an user for controlling and setting the color temperature level of the lighting apparatus.

79. The lighting apparatus according to claim **73**, wherein said second direct touch interface of said second detection device comprises a circuitry to detect a voltage signal generated by a push button interface or a touch pad interface and convert said voltage signal into said second message carrying sensing signal with a time length corresponding to a time interval of said push button interface or touch pad interface being continuously contacted by an user for controlling and setting said light intensity level of said lighting apparatus.

80. The lighting apparatus according to claim **73**, wherein a wireless signal transmitter is further electrically coupled with said microcontroller to convert said first message carrying sensing signal or said second message carrying sensing signal into a wireless signal to remotely control a lighting performance of at least one lighting apparatus.

81. The lighting apparatus according to claim **80**, wherein said wireless signal transmitter is a Wi-Fi wireless signal transmitter, a Bluetooth wireless signal transmitter or a radio frequency wireless signal transmitter.

82. A lighting apparatus comprising:

a first LED lighting load for emitting light with a first color temperature;

a second LED lighting load for emitting light with a second color temperature;

a diffuser, covering said first LED lighting load and said second LED lighting load to create a diffused light with a mingled color temperature;

a clock, providing clock time information to be used for scheduling variation of color temperature of said lighting apparatus according to a programmed pattern of color temperature; and

a microcontroller based electronic switch electrically connected to said first LED lighting load and said second LED lighting load;

wherein said microcontroller based electronic switch further comprising:

a first controllable switching element, electrically connected between said first LED lighting load and a power source for controlling a first electrical power level transmitted to said first LED lighting load;

a second controllable switching element, electrically connected between said second LED lighting load and said power source for controlling a second electrical power level transmitted to said second LED lighting load;

a detection device, for detecting an external control signal and converting said external control signal into a messaging carrying sensing signal; and

a microcontroller to receive and interpret said message carrying sensing signal generated by said detection device, wherein said microcontroller is electrically connected between said first controllable switching element and said detection device, said microcontroller is also electrically connected between said second controllable switching element and said detection device, said microcontroller is designed to execute a task of managing illumination characteristics of said lighting apparatus including light intensity and mingled color temperature;

wherein said microcontroller controls a conduction state, a cutoff state or conduction rates of said first controllable switching element and said second controllable switching element to control electric power transmission levels from said power source respectively to said first LED lighting load and said second LED lighting load according to a process designed for an automatic tuning of said mingled color temperature of said lighting apparatus based on said clock time information provided by said clock and according to a signal format of said message carrying sensing signal generated by said detection device;

wherein said first color temperature is higher than said second color temperature;

wherein said clock time information is either received from said clock electrically connected to said microcontroller or received from a mobile device configured with a clock time capacity through a wireless signal receiver electrically connected with said microcontroller;

wherein said signal format is a short voltage signal, a long voltage signal or a plurality of voltage signals generated in a preset time interval; wherein said short voltage signal and said long voltage signal are respectively defined either by a time length of a voltage signal or by said time length of a voltage signal comprising a series of pulse signals consecutively generated;

wherein when said microcontroller receives said message carrying sensing signal, said microcontroller manages to activate a corresponding process according to said signal format of said message carrying sensing signal to perform one of various working modes including an on/off switch control mode, a dimming control model, a color temperature tuning control mode and a delay shutoff mode.

83. The lighting apparatus according to claim **82**, wherein said detection device is configured with a touch less interface for detecting said external control signal and converting said external control signal into said message carrying sensing signal interpretable to said microcontroller.

84. The lighting apparatus according to claim **83**, wherein said touch less interface is an active infrared ray sensor comprising an infrared ray transmitter for emitting infrared light into an area to form a defined detection zone, an infrared ray receiver for receiving infrared light reflected from an object in said defined detection zone, and a detection circuitry for detecting and generating different voltage signals in response to a motion of said object entering and leaving said defined detection zone; wherein when said object enters said defined detection zone, said detection circuitry operates to generate a first voltage sensing signal with a time length corresponding to a time interval of said object entering and staying in said defined detection zone; wherein when said object leaves said defined detection zone, said detection circuitry operates to generate a second voltage signal to conclude said time length of said first voltage sensing signal, wherein said first voltage sensing signal with said time length is a basic format for configuring said message carrying sensing signal to be delivered to said microcontroller.

85. The lighting apparatus according to claim **83**, wherein said touch less interface is a wireless remote control device electrically coupled to said microcontroller to receive and to convert a wireless external control signal into said message carrying sensing signal with said signal format interpretable to said microcontroller.

86. The lighting apparatus according to claim **85**, wherein said wireless remote control device is a Wi-Fi wireless signal receiver, a Bluetooth wireless signal receiver or a RF (radio frequency) wireless signal receiver, wherein said wireless external control signal, said clock and said clock time information are received from a mobile device.

87. The lighting apparatus according to claim **82**, wherein a wireless signal transmitter is further electrically coupled with said microcontroller to convert said message carrying sensing signal into a wireless control signal to control a lighting performance of at least one remote lighting apparatus.

88. The lighting apparatus according to claim **87**, wherein said wireless signal transmitter is a Wi-Fi wireless signal transmitter, a Bluetooth wireless signal transmitter, a Zigbee wireless signal transmitter, or a radio frequency wireless signal transmitter.

89. The lighting apparatus according to claim **82**, wherein said detection device is configured with a direct touch interface for detecting said external control signal and converting said external control signal into said message carrying sensing signal interpretable to said microcontroller.

90. The lighting apparatus according to claim **89**, wherein said direct touch interface is a detection circuitry operated with a push button or a touch sensor, wherein when an user contacts said direct touch interface for a time interval, said detection circuitry responsively generates a first voltage sensing signal with a time length corresponding to said time interval of said direct touch interface being contacted; when said user withdraws from said direct touch interface, said detection circuitry operates to generate a second voltage signal to conclude said time length of said first voltage sensing signal; wherein said first voltage sensing signal with said time length is a basic format for configuring said message carrying sensing signal to be delivered to said microcontroller.

91. The lighting apparatus according to claim **89**, wherein said direct touch interface is a circuitry to detect a voltage signal generated by a voltage divider and convert a voltage value of said voltage signal into said message carrying sensing signal with said signal format corresponding to said voltage value for setting a total conduction rate of said first controllable switching element and said second controllable switching element.

92. The lighting apparatus according to claim **82**, wherein when said color temperature tuning control mode is performed, said conduction rate of said first controllable switching element and said conduction rate of said second controllable switching element are reversely adjusted with the same pace controlled by said microcontroller such that a total power level transmitted to said first LED lighting load and said second LED lighting load remains unchanged, wherein said mingled color temperature of said lighting apparatus is varied based on a predetermined color temperature schedule comprising paired combinations of different conduction rates respectively set for operating said first controllable switching element and said second controllable switching element for a selection according to said clock time information at the time when said message carrying sensing signal is received by said microcontroller.

93. The lighting apparatus according to claim **82**, wherein when the first controllable switching element and the second controllable switching element are in the conduction state, said microcontroller further controls a first electrical power level transmitted from the power source to the first LED lighting load and a second electrical power level transmitted from the power source to the second LED lighting load according to the signal format of said message carrying sensing signal received from said detection device, wherein the first electrical power level transmitted to the first LED lighting load and the second electrical power level transmitted to the second LED lighting load are designed to be unidirectionally and proportionally adjusted with the same pace such that the ratio of said first electrical power level to said second electrical power level is maintained at a constant level to perform the dimming control mode.

94. A lighting apparatus comprising:

a first LED lighting load for emitting light with a first color temperature;

a second LED lighting load for emitting light with a second color temperature;

a diffuser, covering said first LED lighting load and said second LED lighting load to create a diffused light with a mingled color temperature; and

a microcontroller based electronic switch electrically connected to said first LED lighting load and said second LED lighting load, comprising:

a first controllable switching element, electrically connected between said first LED lighting load and a power source;

a second controllable switching element, electrically connected between said second LED lighting load and said power source;

a detection device, for detecting and converting an external control signal into a message carrying sensing signal;

a wireless signal transmitter, for transmitting a coded wireless control signal converted from said message carrying sensing signal; and

a microcontroller to receive and interpret said message carrying sensing signal generated by said detection device, wherein said microcontroller is electrically connected between said first controllable switching element and said detection device, said microcontroller is also electrically connected between said second controllable switching element and said detection device, said microcontroller is also electrically coupled to said wireless signal transmitter for controlling a lighting performance of at least a second lighting apparatus located in a different location;

wherein said microcontroller controls a conduction state, a cutoff state or conduction rates of said first controllable switching element and said second controllable switching element to control electric power transmission levels from said power source respectively to said first LED lighting load and said second LED lighting load according to said message carrying sensing signal generated by said detection device;

wherein said first color temperature is higher than said second color temperature;

wherein said detection device is a wireless remote control device electrically coupled to a pin of said microcontroller to receive and convert a wireless external control signal into said message carrying sensing with a signal format interpretable to said microcontroller, wherein said signal format of said message carrying sensing signal is a voltage signal with a short time length, a voltage signal with a long time length or a plurality of voltage signals generated in a preset time interval; wherein the short voltage signal and the long voltage signal are respectively defined either by a time length of a voltage signal or by the time length of a voltage signal comprising a series of pulse signals consecutively generated;

wherein when said microcontroller receives said message carrying sensing signal, said microcontroller manages to activate a corresponding process according to said signal format of said message carrying sensing signal to perform at least one of various working modes including at least an on/off switch control mode, a dimming

control mode for selecting light intensity, a color temperature tuning mode for selecting light color, a color temperature switching mode and a delay timer control mode for managing delay shutoff before switching off the light.

95. The lighting apparatus according to claim **94**, wherein said wireless remote control device is a Wi-Fi wireless control signal receiver, a Bluetooth wireless control signal receiver or a RF (radio frequency) wireless control signal receiver.

96. The lighting apparatus according to claim **94** wherein said lighting apparatus is configured as a commanding lamp in a lighting family comprising a plurality of member lamps installed in different locations in a living space for providing illumination; wherein said commanding lamp receives said wireless external control signal and converts said wireless external control signal into said message carrying sensing signal interpretable to said microcontroller to control lighting performances of said commanding lamp or at least one member lamp, wherein for controlling said at least one member lamp, said microcontroller manages to convert said message carrying sensing signal into said coded wireless control signal for transmitting to at least one member lamp, wherein upon receiving said coded wireless control signal said wireless remote control device of said at least one member lamp manages to convert said coded wireless control signal into said message carrying sensing signal interpretable to said microcontroller of said at least one member lamp for controlling lighting performance of said at least one member lamp.

97. The lighting apparatus according to claim **94**, wherein said wireless signal transmitter is a Wi-Fi wireless signal transmitter, a Bluetooth wireless signal transmitter, a Zigbee wireless signal transmitter or a radio frequency wireless signal transmitter.

98. The lighting apparatus according to claim **94**, wherein said microcontroller comprises a memory for saving or installing an application program (APP) or a software program, wherein said application program (APP) from an internet or a cloud server is downloaded for updating the memory of said microcontroller.

99. A lighting apparatus comprising;

a first LED lighting load for emitting light with a first color temperature;

a second LED lighting load for emitting light with a second color temperature;

a diffuser, covering said first lighting load and said second lighting load to create a diffused light with a mingled color temperature; and

a microcontroller based electronic switch electrically connected to said first LED lighting load and said second LED lighting load, comprising:

a first controllable switching element, electrically connected between said first LED lighting load and a power source;

a second controllable switching element, electrically connected between said second LED lighting load and said power source;

a detection device, for detecting an external control signal and converting said external control signal into a message carrying sensing signal; and

a microcontroller to receive and interpret said message carrying sensing signal generated by said detection device, wherein said microcontroller is electrically connected between said first controllable switching element and said detection device, said microcontroller is electrically connected between said second controllable switching element and said detection device, said microcontroller controls a conduction state, a cutoff state or conduction rates of said first controllable switching element and said second controllable switching element to control electric power transmission levels from said power source respectively to said first LED lighting load with said first color temperature and said second LED lighting load with said second color temperature according to said message carrying sensing signal generated by said detection device;

wherein said first color temperature is higher than said second color temperature;

wherein said detection device is a detection circuit electrically coupled with said microcontroller to detect a signal of a short power interruption and convert said short power interruption signal into said message carrying sensing signal interpretable to said microcontroller, wherein when said microcontroller receives said message carrying sensing signal to perform a color temperature switching control mode, said microcontroller operates to change conduction rates of said first controllable switching element and said second controllable switching element according to paired combinations of conduction rates between said first controllable switching element and said second controllable switching element to alternately perform a different mingled color temperature, wherein the total conduction rate of said first controllable switching element and said second controllable switching element is managed at a constant level.

100. The lighting apparatus according to claim **99**, wherein said paired combinations of conduction rates between said first controllable switching element and said second controllable comprises at least a first combination and a second combination, wherein said first combination is designed with an arrangement that said first controllable switching element is in a full conduction state while said second controllable switching element is in a complete cutoff state, wherein said second combination is designed with an arrangement that said first controllable switching element is in a complete cutoff state while said second controllable switching element is in a full conduction state, said lighting apparatus thereby alternatively performs between a first color temperature illumination and a second color temperature illumination according to said message carrying sensing signal received by said microcontroller.

101. A microcontroller based electronic switch for controlling a lighting performance of an LED lamp configured with a plurality of LED lighting loads comprising

a first controllable switching element, electrically connected between a first LED lighting load for emitting light with a first color temperature and a power source;

a second controllable switching element, electrically connected between a second LED lighting load for emitting light with a second color temperature and said power source;

a first detection device for detecting a first external control signal and converting said first external control signal into a first message carrying sensing signal;

a second detection device for detecting a second external control signal and converting said second external control signal into a second message carrying sensing signal; and

a microcontroller through a first control pin receives said first message carrying sensing signal generated by said first detection device, said microcontroller through a

second control pin receives said second message carrying sensing signal generated by said second detection device, wherein said microcontroller through a third control pin is electrically coupled to said first controllable switching element, wherein said microcontroller through a fourth control pin is electrically coupled to said second controllable switching element;

wherein said first color temperature is higher than said second color temperature;

wherein said first detection device and said second detection device are direct touch interface;

wherein when said first controllable switching element and said second controllable switching element are in conduction state, said microcontroller further controls electric power transmission levels from said power source respectively to said first LED lighting load and to said second LED lighting load according to said first message carrying sensing signal or said second message carrying sensing signal received, wherein said microcontroller through said third control pin outputs a first control signal to control conduction rate of said first controllable switching element, said microcontroller through said fourth control pin outputs a second control signal to control conduction rate of said second controllable switching element;

wherein said first message carrying sensing signal and said second message carrying sensing signal are characterized with a signal format with a time length, wherein said time length of said signal format is defined either by a time duration of a voltage signal or by said time duration of a series of pulse signals consecutively generated; wherein when said microcontroller receives said first message carrying sensing signal, said microcontroller manages to activate a first process to control a light intensity of a diffused light through a light diffuser covering said first LED lighting load and said second LED lighting load according to said time length of said first message carrying sensing signal, wherein when said microcontroller receives said second message carrying sensing signal, said microcontroller manages to activate a second process to reversely control said light intensity of said diffused light through said light diffuser according to said time length of said second message carrying sensing signal, wherein said first process and said second process are designed to operate a reverse function to each other for adjusting said light intensity of said LED lamp; wherein said first process operates to increase and set said light intensity of said

LED lamp by proportionately increasing conduction rates of said first controllable switching element and said second controllable switching element according to said time length of said first message carrying sensing signal, wherein said second process operates to decrease and set said light intensity of said LED lamp by proportionately decreasing conduction rates of said first controllable switching element and said second controllable switching element according to said time length of said second message carrying sensing signal;

wherein said microcontroller is an integrated circuit programmable for generating said first control signal and said second control signal, or an application specific integrated circuit (ASIC) custom made for generating said first control signal and said second control signal.

102. The microcontroller based electronic switch according to claim **101**, wherein said first detection device and said second detection device are integrated into a seesaw device, wherein one end of said seesaw device performs the function of said first detection device while the other end of said seesaw device performs the function of said second detection device for adjusting and setting said light intensity of said LED lamp.

103. The microcontroller based electronic switch according to claim **101**, wherein a third detection device is furthered installed and coupled to a control pin of said microcontroller for controlling an on/off performance of said LED lamp, wherein said third detection device is a direct touch interface electrically coupled to said microcontroller for detecting a third external control signal and converting said third external control signal into a third message carrying sensing signal, wherein when said microcontroller receives said third message carrying sensing signal, said microcontroller operates to alternatively turn on or turn off said LED lamp.

104. The microcontroller based electronic switch according to claim **101**, wherein a power switch is further installed to turn on or turn off said LED lamp.

105. The microcontroller based electronic switch according to claim **101**, wherein said direct touch interface is a detection circuitry operated with a push button device or a touch sensor device, wherein when an user contacts said direct touch interface for a time interval, said detection circuitry responsively generates a first voltage signal with a time length corresponding to said time interval of said direct touch interface being contacted; wherein when said user withdraws from said direct touch interface, said detection circuitry delivers a second voltage signal; said first voltage signal with said time length is a basic format for configuring said first message carrying sensing signal and said second message carrying sensing signal to be delivered to said microcontroller.

106. A microcontroller based electronic switch for controlling a lighting performance of an LED lamp configured with a plurality of LED lighting loads comprising

a first controllable switching element, electrically connected between a first LED lighting load for emitting light with a first color temperature and a power source;

a second controllable switching element, electrically connected between a second LED lighting load for emitting light with a second color temperature and said power source;

a first detection device for detecting a first external control signal and converting said first external control signal into a first message carrying sensing signal;

a second detection device for detecting a second external control signal and converting said second external control signal into a second message carrying sensing signal; and

a microcontroller through a first control pin receives said first message carrying sensing signal generated by said first detection device, said microcontroller through a second control pin receives said second message carrying sensing signal generated by said second detection device, wherein said microcontroller through a third control pin is electrically coupled to said first controllable switching element, wherein said microcontroller through a fourth control pin is electrically coupled to said second controllable switching element;

wherein said first color temperature is higher than said second color temperature;

wherein said first detection device and said second detection device are direct touch interfaces;

wherein when said first controllable switching element and said second controllable switching element are in

conduction state, said microcontroller further controls electric power transmission levels from said power source respectively to said first LED lighting load and to said second LED lighting load according to said first message carrying sensing signal or said second message carrying sensing signal received, wherein said microcontroller through said third control pin outputs a first control signal to control conduction rate of said first controllable switching element, said microcontroller through said fourth control pin outputs a second control signal to control conduction rate of said second controllable switching element;

wherein said first message carrying sensing signal and said second message carrying sensing signal are characterized with a signal format with a time length, wherein said time length of said signal format is defined either by a time duration of a voltage signal or by said time duration of a series of pulse signals consecutively generated;

wherein when said microcontroller receives said first message carrying sensing signal, said microcontroller manages to activate a first process to control a light color temperature of a diffused light through a light diffuser covering said first LED lighting load and said second LED lighting load of said LED lamp according to said time length of said first message carrying sensing signal, wherein when said microcontroller receives said second message carrying sensing signal, said microcontroller manages to activate a second process to reversely control said light color temperature of said diffused light through said light diffuser according to said time length of said second message carrying sensing signal, wherein said first process and said second process are designed to operate a reverse function to each other for adjusting said light color temperature of said diffused light through said light diffuser of the LED lamp; wherein said first process operates to decrease conduction rate of said first controllable switching element and at the same time to increase conduction rate of said second controllable switching element with an arrangement that the total electric power transmitted to said first LED lighting load and said second LED lighting load is maintained at a constant level for decreasing and setting said light color temperature of said LED lamp according to said time length of said first message carrying sensing signal, wherein said second process operates to increase conduction rate of said first controllable switching element and at the same time to decrease conduction rate of said second controllable switching element with said arrangement that the total electric power transmitted to said first LED lighting load and said second LED lighting load is maintained at the constant level for increasing and setting said light color temperature of said LED lamp.

107. The microcontroller based electronic switch according to claim **106**, wherein said first detection device and said second detection device are integrated into a seesaw device, wherein one end of said seesaw device performs a function of said first detection device while the other end of said seesaw device performs a function of said second detection device for adjusting and setting said light color temperature of said LED lamp.

108. The microcontroller based electronic switch according to claim **106**, wherein a third detection device is furthered installed and coupled to a control pin of said microcontroller for controlling an on/off switch operation of said LED lamp, wherein said third detection device is a direct touch interface electrically coupled to said microcontroller for detecting a third external control signal and converting said third external control signal into a third message carrying sensing signal, wherein when said microcontroller receives said third message carrying sensing signal, said microcontroller operates to alternatively turn on or turn off said LED lamp.

109. The microcontroller based electronic switch according to claim **106**, wherein a power switch is further installed to turn on or turn off said LED lamp.

110. The microcontroller based electronic switch according to claim **106**, wherein said direct touch interface is a detection circuitry operated with a push button device or a touch sensor device, wherein when an user contacts said direct touch interface for a time interval, said detection circuitry responsively generates a first voltage signal with a time length corresponding to said time interval of said direct touch interface being contacted; wherein when said user withdraws from said direct touch interface, said detection circuitry delivers a second voltage signal; said first voltage signal with said time length is a basic format for configuring said first message carrying sensing signal and said second message carrying sensing signal to be delivered to said microcontroller.

* * * * *

EXHIBIT B

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(12) **United States Patent**
Chen

(10) **Patent No.: US 10,187,947 B2**
(45) **Date of Patent: *Jan. 22, 2019**

(54) **LIFE-STYLE LED SECURITY LIGHT**

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(72) Inventor: **Chia-Teh Chen**, Taipei (TW)

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H05B 37/02 (2006.01)
H05B 33/08 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H05B 33/0854*** (2013.01); ***F21S 9/03*** (2013.01); ***F21V 17/02*** (2013.01); ***G08B 5/36*** (2013.01); ***G08B 13/1895*** (2013.01); ***G08B 15/00*** (2013.01); ***G08B 15/002*** (2013.01); ***H02J 7/35*** (2013.01); ***H05B 33/083*** (2013.01); ***H05B 33/0809*** (2013.01); ***H05B 33/0815*** (2013.01); ***H05B 33/0818*** (2013.01); ***H05B 33/0824*** (2013.01); ***H05B 33/0827*** (2013.01); ***H05B 33/0872*** (2013.01); ***H05B 37/02*** (2013.01); ***H05B 37/0218*** (2013.01); ***H05B 37/0227*** (2013.01); ***H05B 37/0281*** (2013.01); ***H05B 39/042*** (2013.01); ***H05B 39/044*** (2013.01); *F21Y 2115/10* (2016.08);
(Continued)

(58) **Field of Classification Search**
CPC H05B 33/0815; H05B 33/0845; H05B 33/0848; H05B 37/0218; H05B 37/0227; H05B 37/0281
USPC 315/149, 152, 154, 307, 308, 312
See application file for complete search history.

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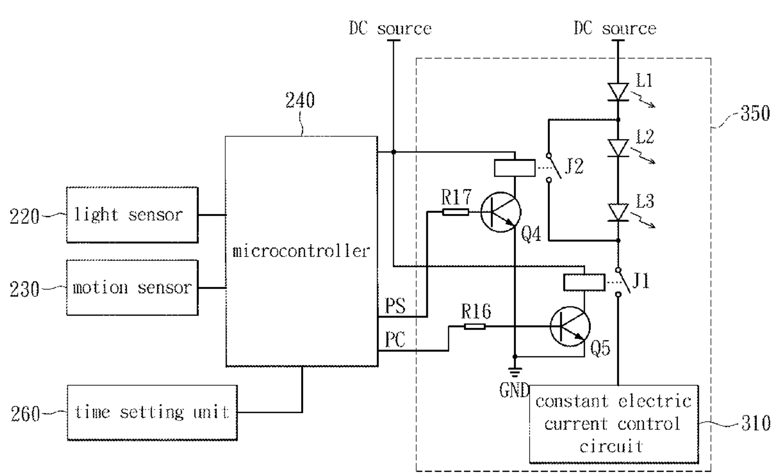
(74) *Attorney, Agent, or Firm* — Rosenberg, Klein & Lee

(57) **ABSTRACT**

A two-level LED security light within it has a light-emitting unit including an LED load which may be turned on or turned off by a loading and power control unit activated by a light sensing control unit and a motion sensing unit. When the motion sensing unit detects a motion signal, the light-emitting unit is switched to a high level illumination for a predetermined time length adjustable by a time setting unit, and then the loading and power control unit manages to turn off the light-emitting unit thru a soft off process. The LED load is configured with a plurality of LEDs accommodating to the power supply unit wherein a voltage V across each LED is confined in a range $V_{th}<V<V_{max}$, with V_{th} being a minimum voltage to turn on the LED and V_{max} a maximum voltage to avoid damaging the LED.

61 Claims, 16 Drawing Sheets



Related U.S. Application Data

No. 15/230,752, filed on Aug. 8, 2016, now Pat. No. 9,743,480, which is a continuation of application No. 14/478,150, filed on Sep. 5, 2014, now Pat. No. 9,445,474, which is a continuation of application No. 13/222,090, filed on Aug. 31, 2011, now Pat. No. 8,866,392.

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F21V 17/02	(2006.01)
G08B 5/36	(2006.01)
H02J 7/35	(2006.01)
G08B 13/189	(2006.01)
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G08B 13/00	(2006.01)

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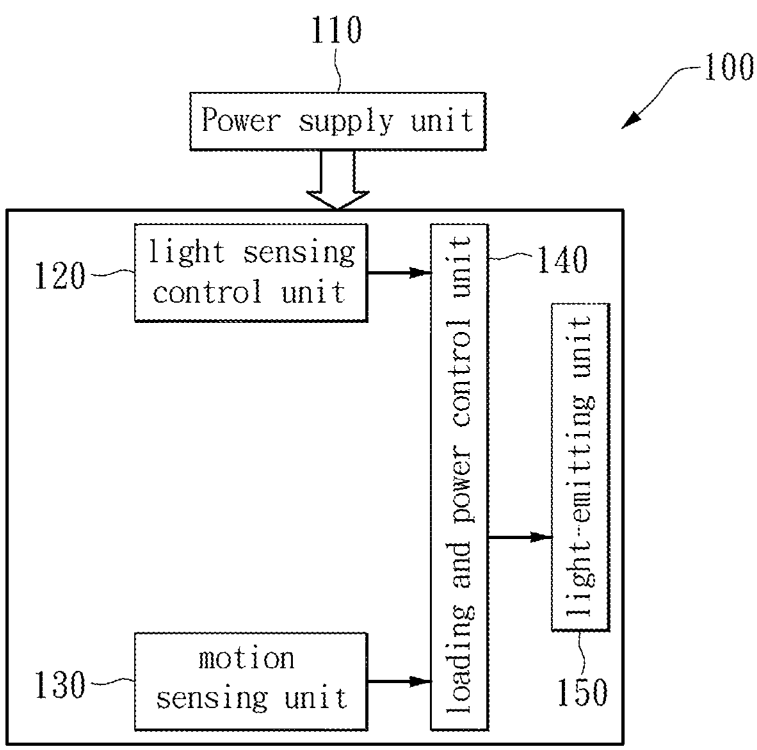

110
100
Power supply unit
120
light sensing control unit
140
loading and power control unit
light-emitting unit
130
motion sensing unit
150

FIG. 1

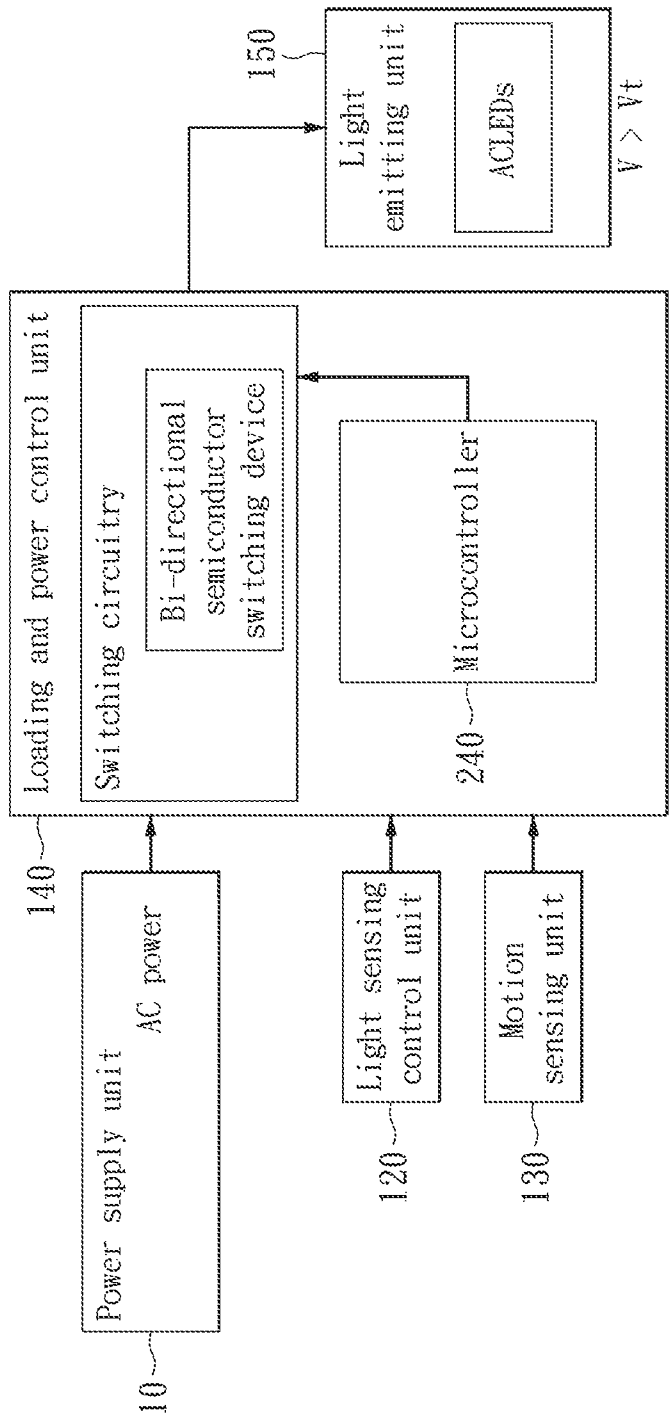

150
Light emitting unit
ACLEDs
V > Vt
Loading and power control unit
Switching circuitry
Bi-directional semiconductor switching device
Microcontroller
240
140
Power supply unit
AC power
110
Light sensing control unit
120
Motion sensing unit
130

FIG. 1A

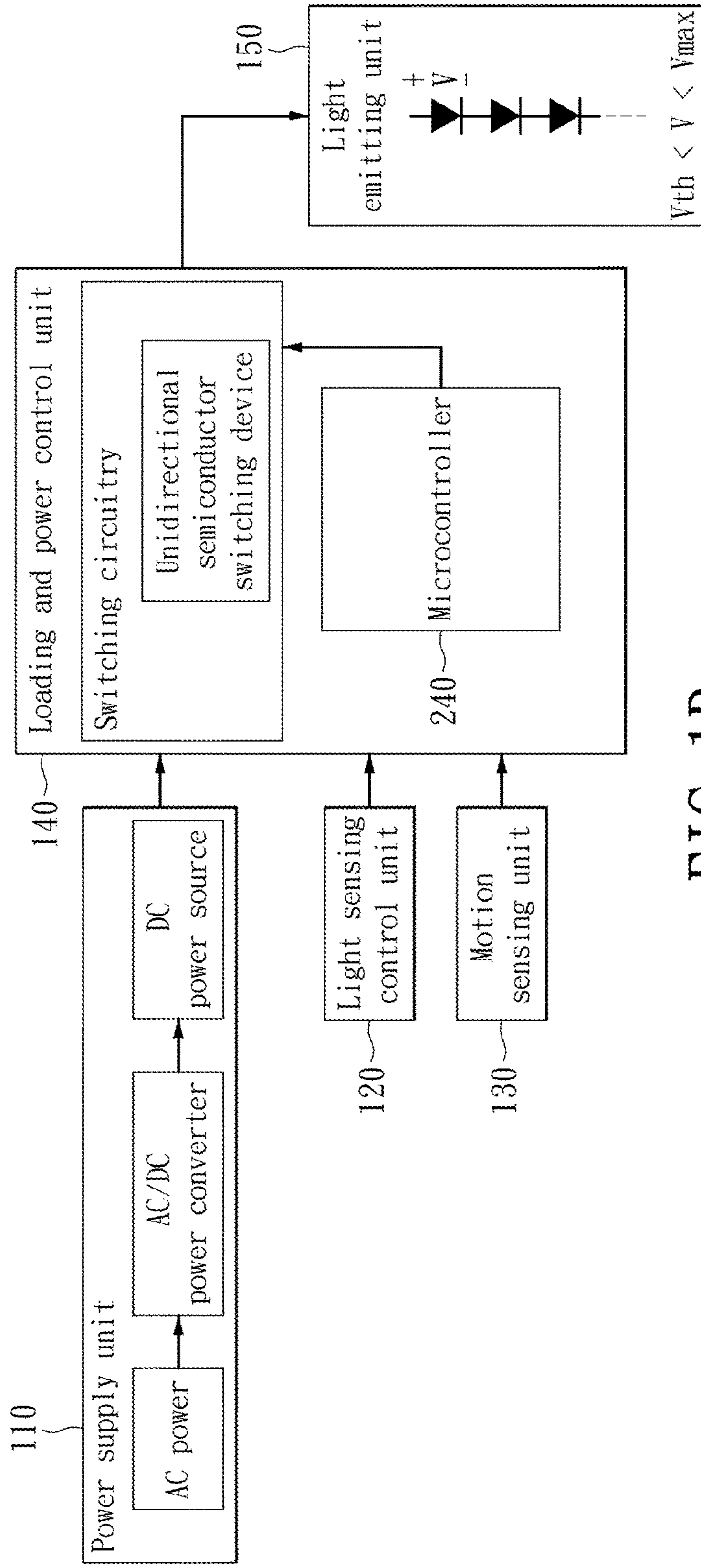

110
Power supply unit
AC power
AC/DC power converter
DC power source
140
Loading and power control unit
Switching circuitry
Unidirectional semiconductor switching device
Microcontroller
240
120
Light sensing control unit
130
Motion sensing unit
150
Light emitting unit
+ V −
Vth < V < Vmax

FIG. 1B

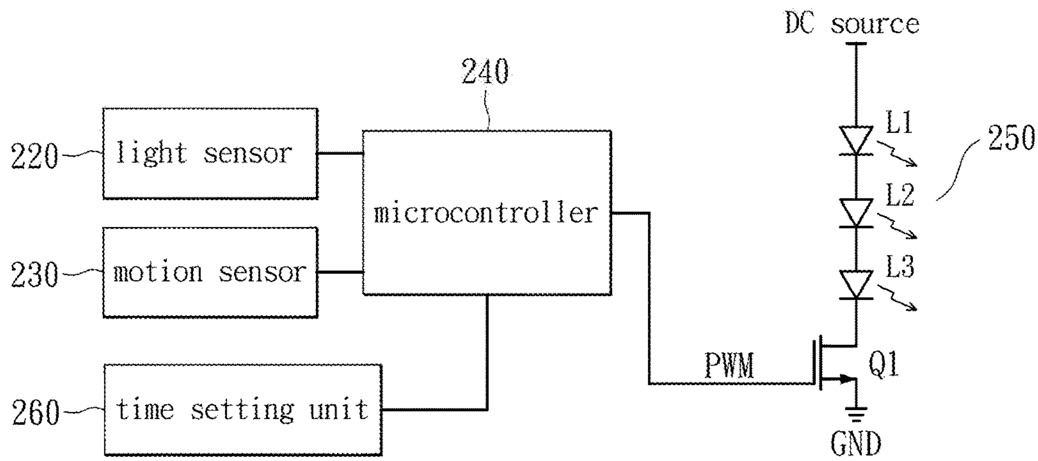

DC source
240
220
light sensor
microcontroller
L1
250
L2
230
motion sensor
L3
PWM
Q1
260
time setting unit
GND

FIG. 2A

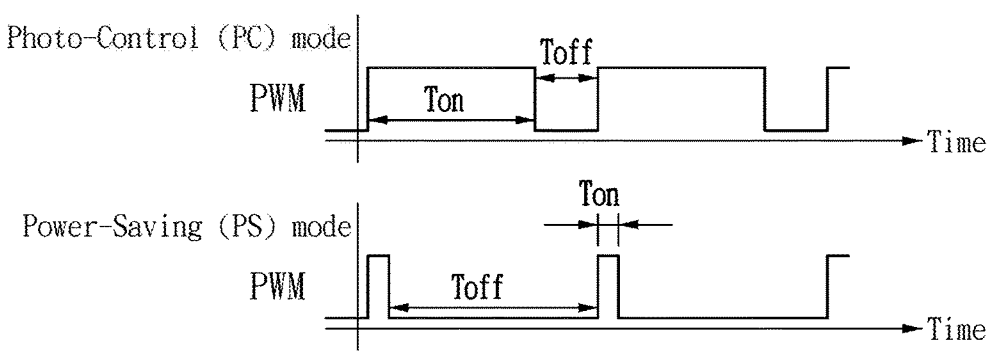
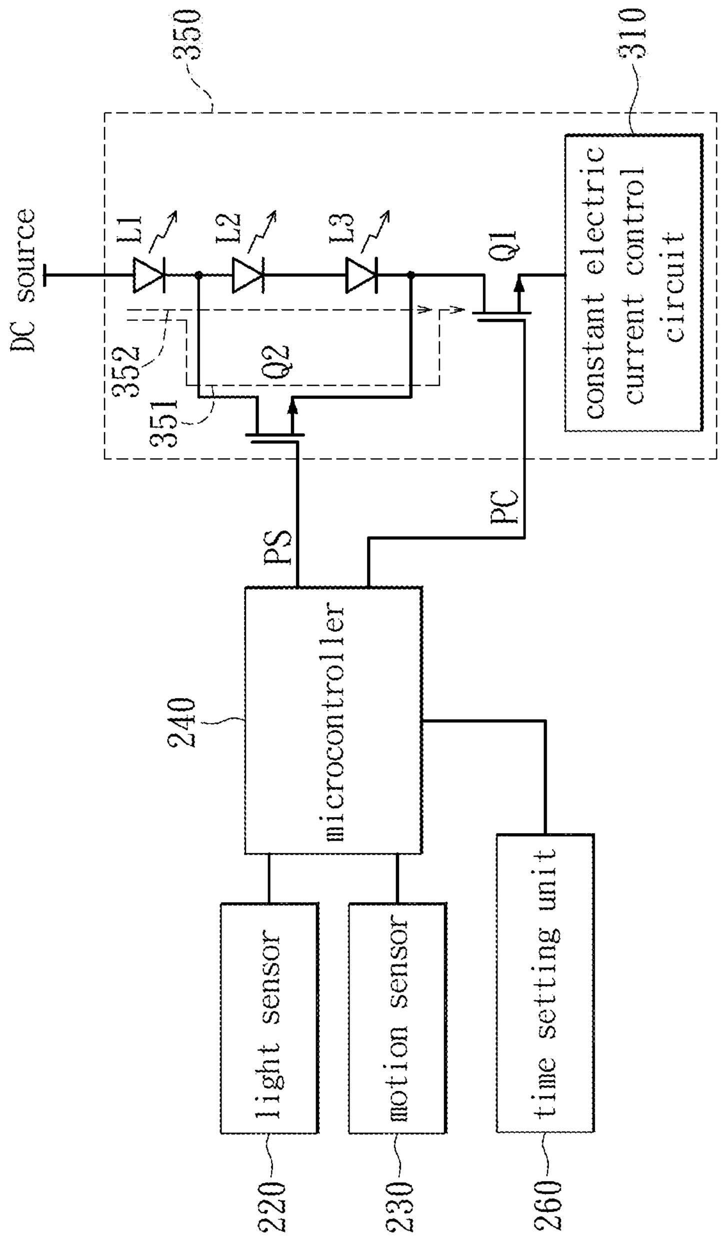


Photo-Control (PC) mode
Toff
PWM
Ton
Time
Ton
Power-Saving (PS) mode
PWM
Toff
Time

FIG. 2B



DC source
L1
L2
L3
Q1
Q2
350
310
352
351
constant electric current control circuit
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 3A

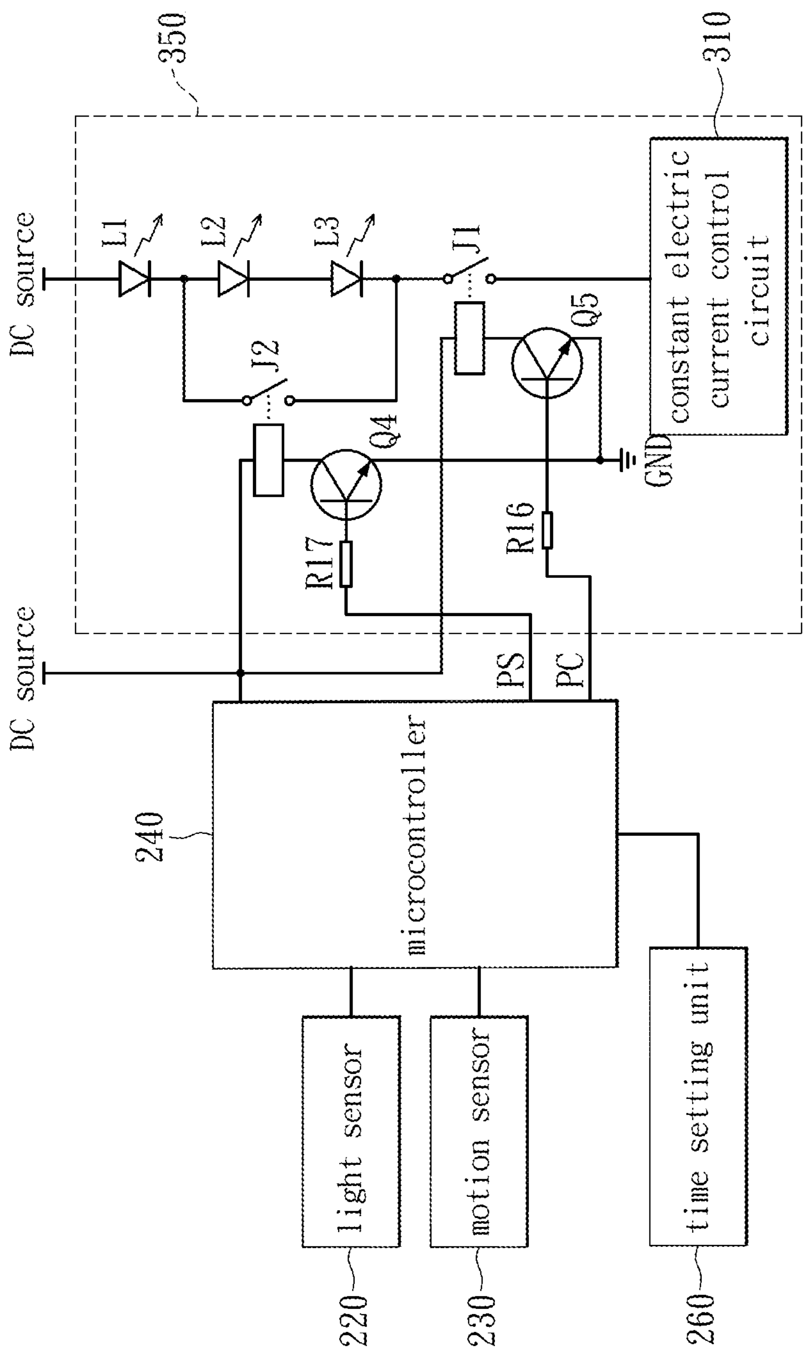

350
310
DC source
L1
L2
L3
J1
J2
Q4
Q5
R16
R17
GND
constant electric current control circuit
DC source
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 3B

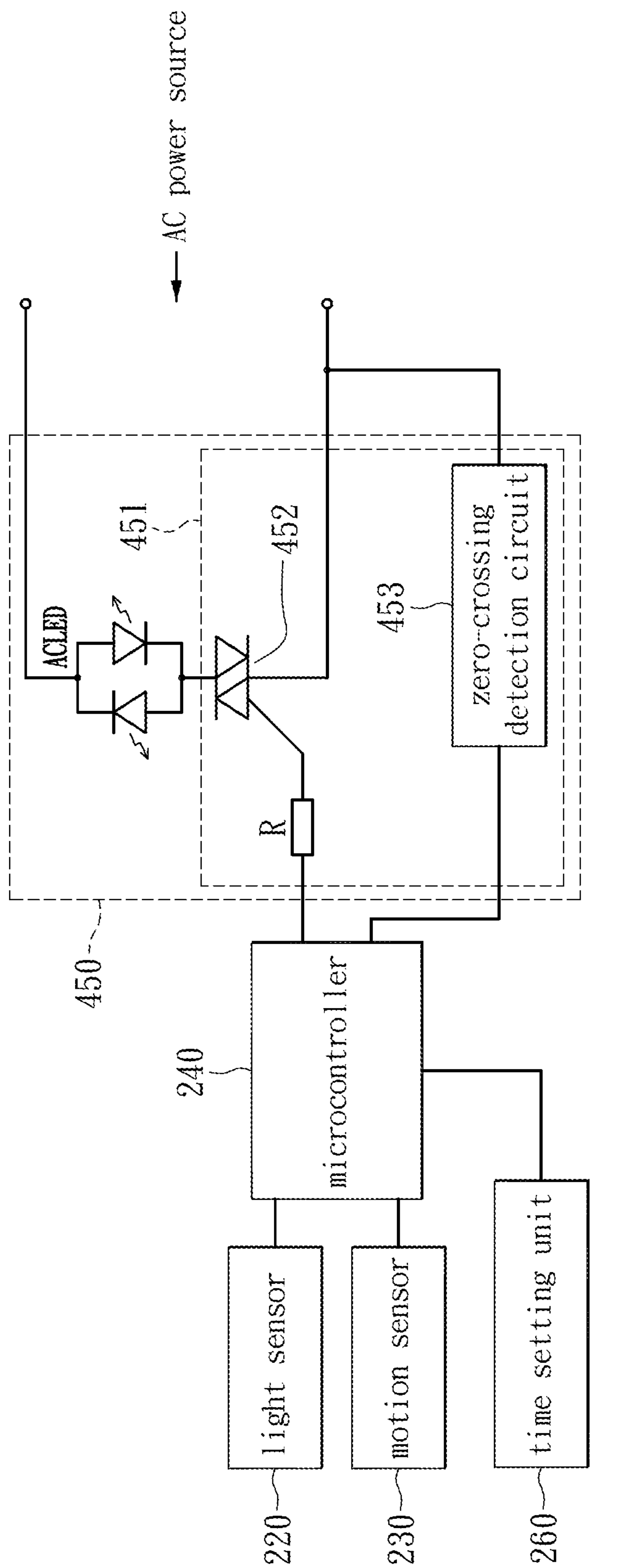

AC power source
450
451
452
453
ACLED
R
zero-crossing detection circuit
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 4A

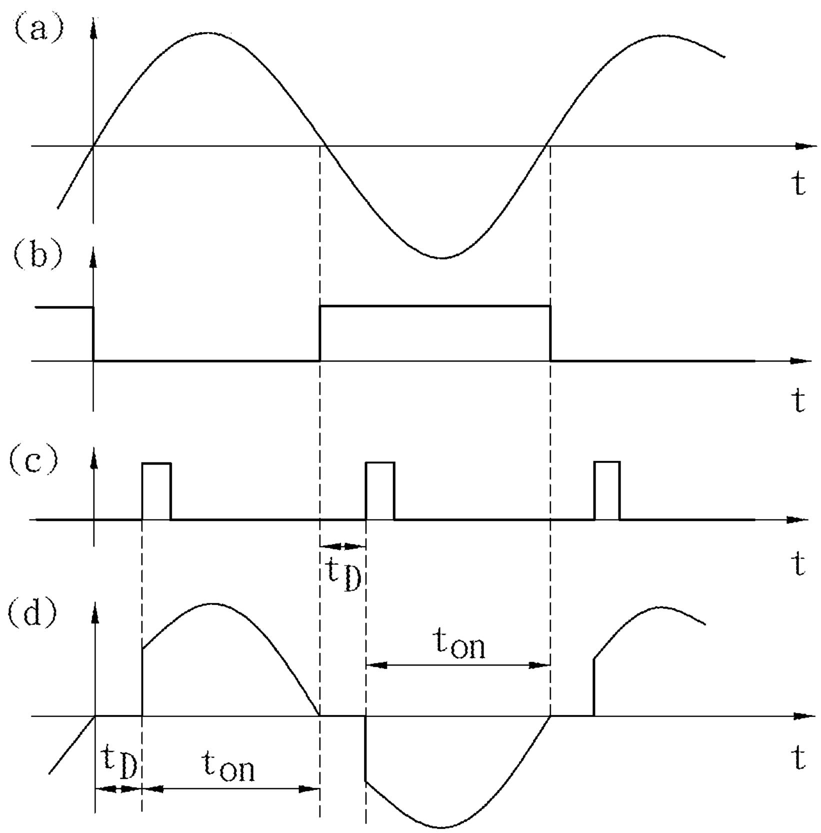


FIG. 4B

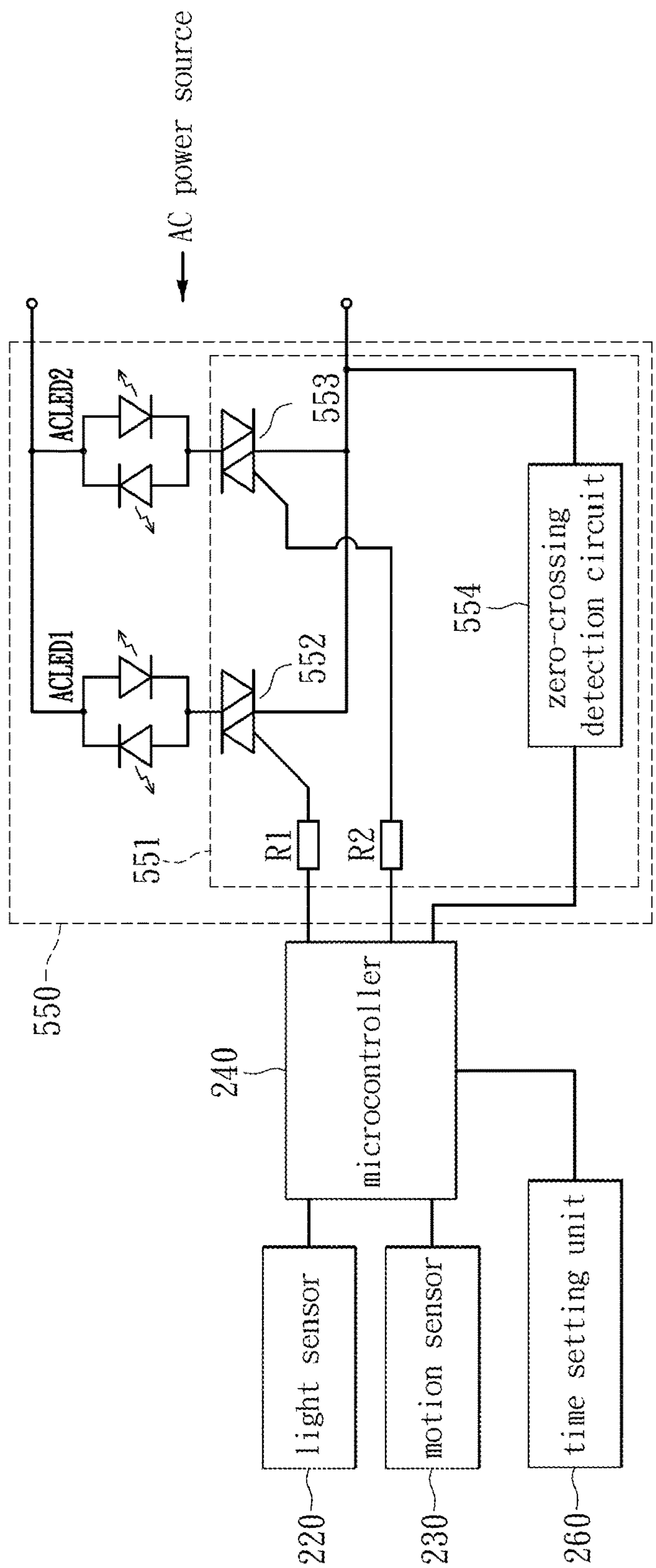

AC power source
ACLED2
ACLED1
553
552
551
R1
R2
554
zero-crossing detection circuit
550
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 5

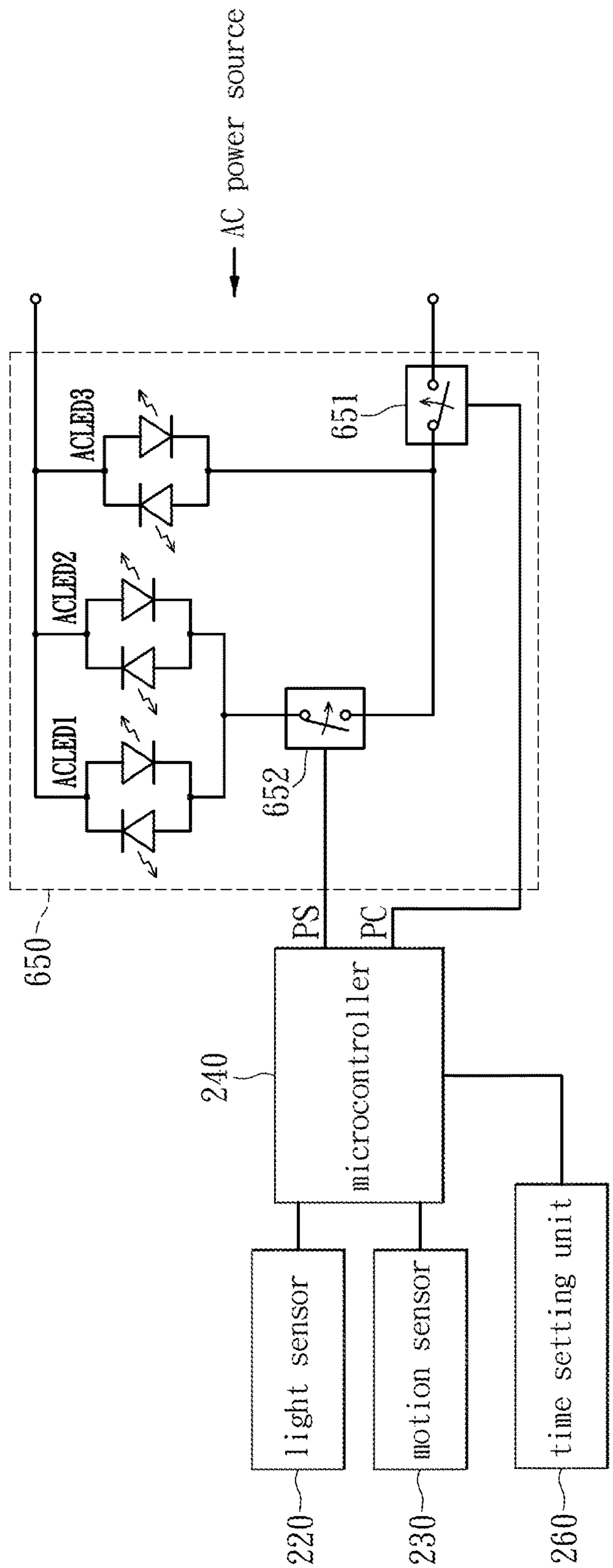

AC power source
ACLED1
ACLED2
ACLED3
651
652
650
PS
PC
microcontroller
240
light sensor
motion sensor
time setting unit
220
230
260

FIG. 6

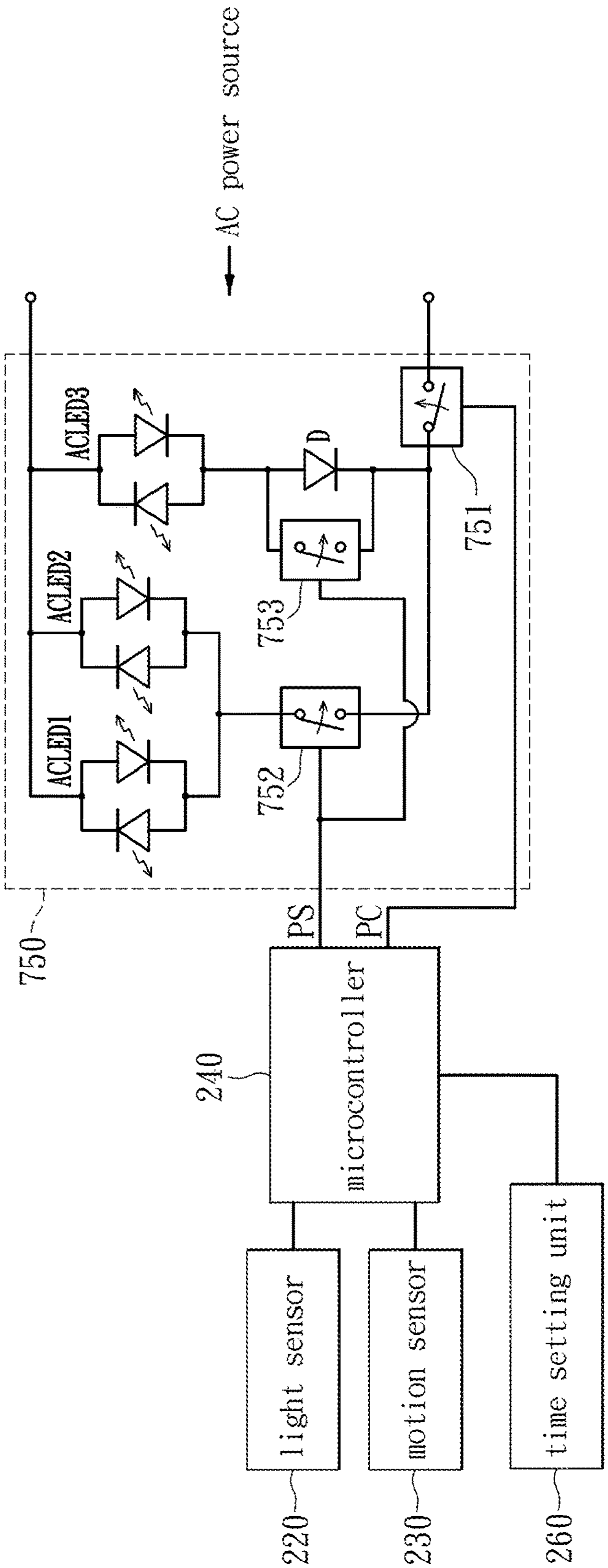

AC power source
ACLED3
ACLED2
ACLED1
D
751
752
753
750
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 7

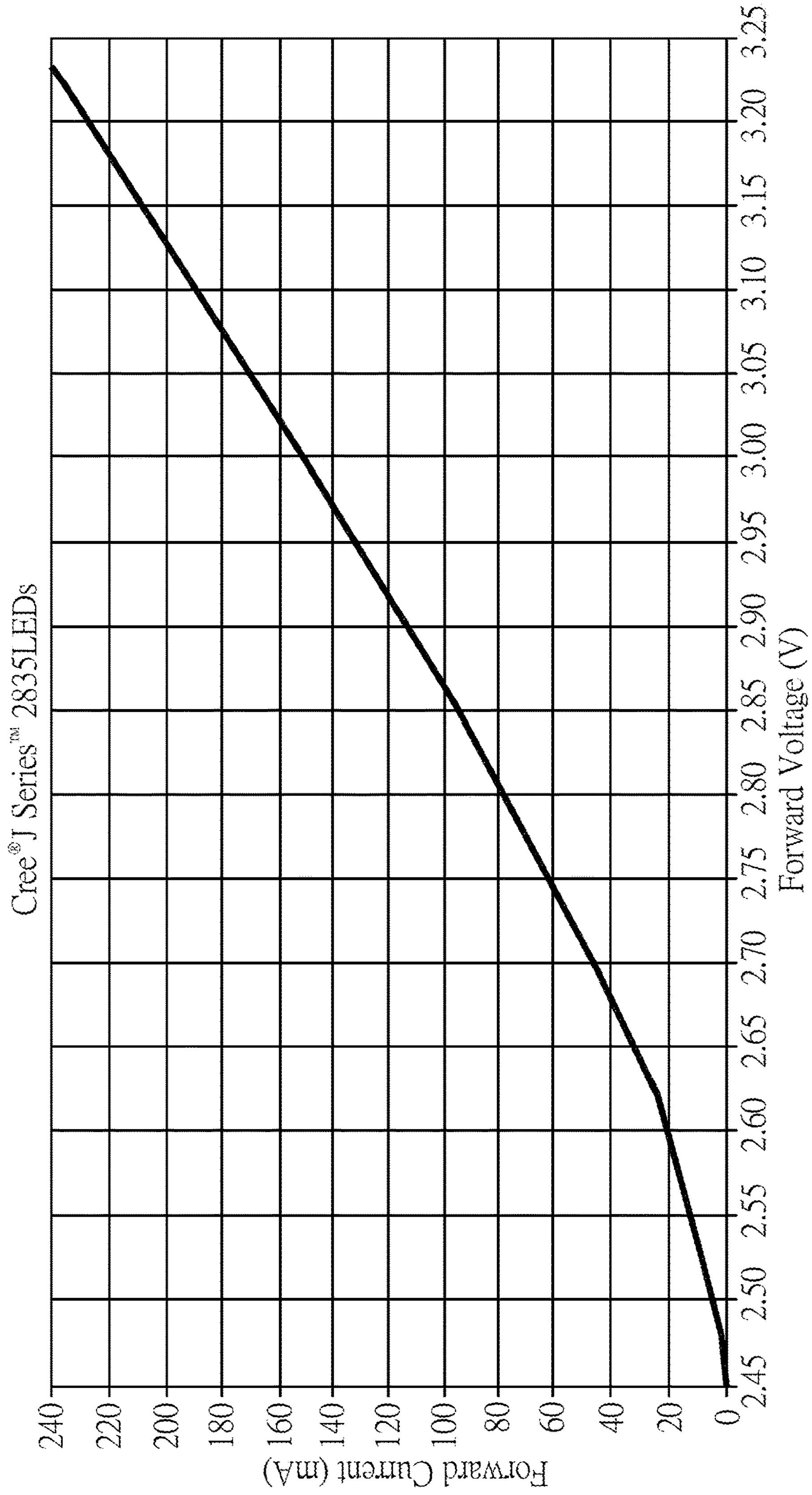

Cree® J Series™ 2835LEDs
Forward Current (mA)
0
20
40
60
80
100
120
140
160
180
200
220
240
Forward Voltage (V)
2.45
2.50
2.55
2.60
2.65
2.70
2.75
2.80
2.85
2.90
2.95
3.00
3.05
3.10
3.15
3.20
3.25

FIG. 8A

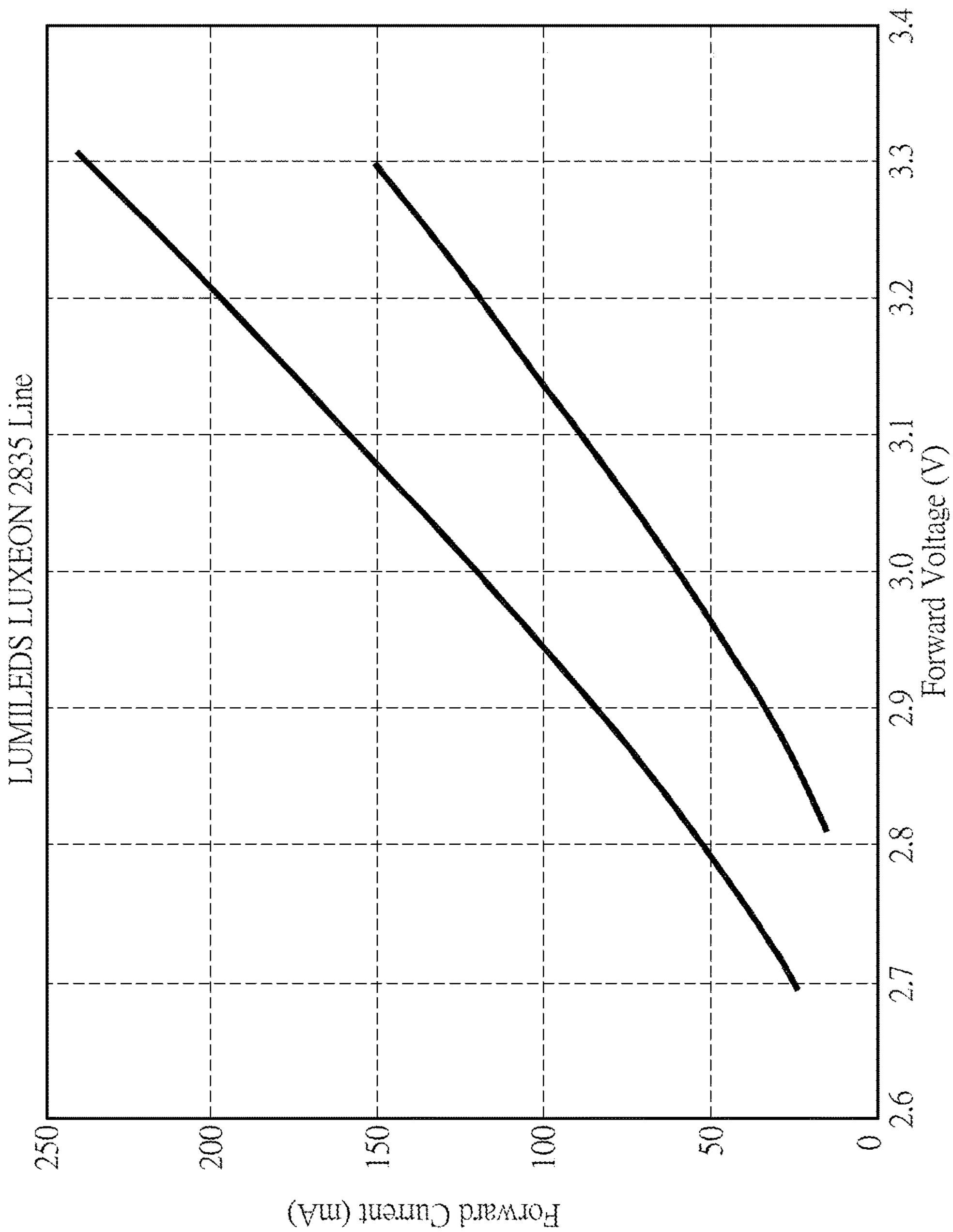

LUMILEDS LUXEON 2835 Line
Forward Current (mA)
250
200
150
100
50
0
2.6
2.7
2.8
2.9
3.0
3.1
3.2
3.3
3.4
Forward Voltage (V)

FIG. 8B

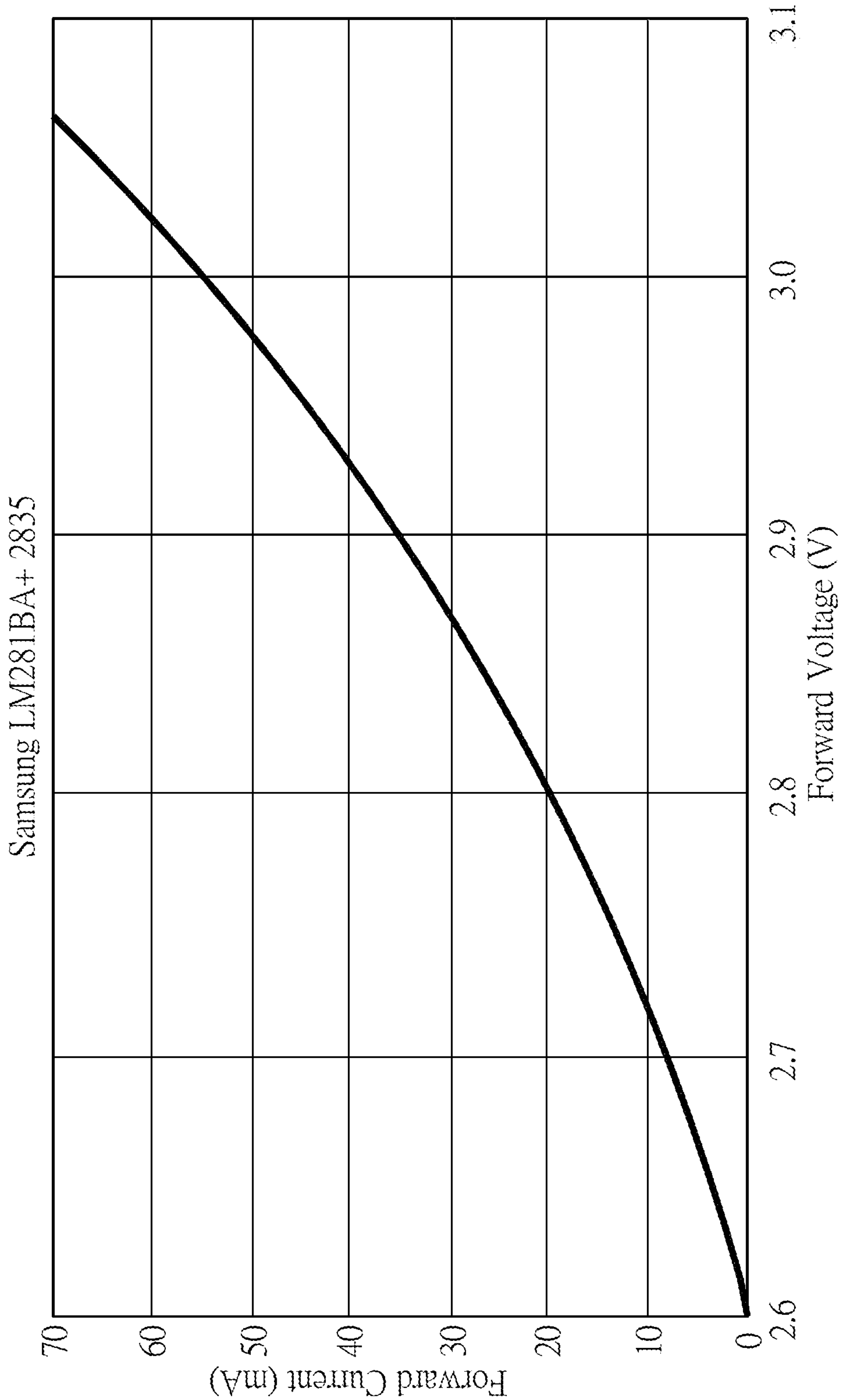

Samsung LM281BA+ 2835
Forward Current (mA)
0
10
20
30
40
50
60
70
2.6
2.7
2.8
2.9
3.0
3.1
Forward Voltage (V)

FIG. 8C

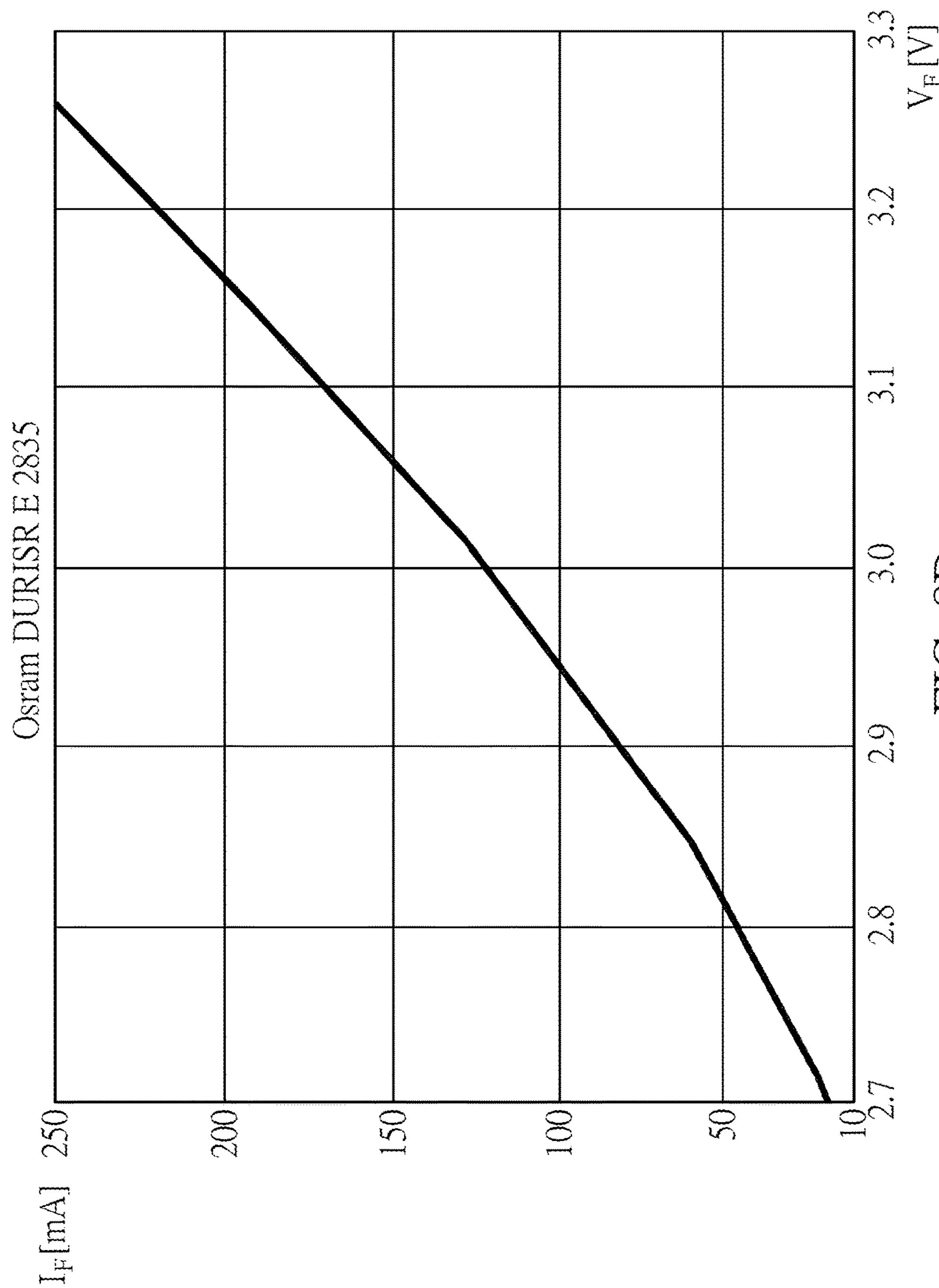

Osram DURISR E 2835
I_F [mA]
250
200
150
100
50
10
2.7
2.8
2.9
3.0
3.1
3.2
3.3
V_F [V]

FIG. 8D

Brand	V_F Min.	V_F Max.	Product Series	Information Source
CREE	2.9V	3.3V	J Series LEDs/J Series 2835	www.cree.com/led-components/products/j2835/jseries-2835
LUMILEDS	2.7V	3.3V	LUXEON 2835 Line	www.lumileds.com/luxeon2835line
SAMSUNG	2.9V	3.3V	KM281BA+	www.samsung.com/app/components/products/j2835/jseries-2835
OSRAM	2.7V	3.3V	DURIS® E/DURISR E 2835	www.osram.com/app/product_selector/#!?query=DORIS%20E%202835&sortField=&sortOrder=&start-0&filters=productbrand,DORIS,E&filters-productbrand,DORIS

FIG. 9

LIFE-STYLE LED SECURITY LIGHT

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a continuation application of prior application Ser. No. 15/637,175 filed on Jun. 29, 2017, currently pending, which is a continuation application of prior application Ser. No. 15/230,752 filed on Aug. 8, 2016, issued as U.S. Pat. No. 9,743,480 on Aug. 22, 2017, which is a continuation application of prior application Ser. No. 14/478,150 filed on Sep. 5, 2014, issued as U.S. Pat. No. 9,445,474 on Sep. 13, 2016, which is a continuation application of prior application Ser. No. 13/222,090 filed on Aug. 31, 2011, issued as U.S. Pat. No. 8,866,392 on Oct. 21, 2014.

BACKGROUND

1. Technical Field

The present disclosure relates to a lighting apparatus, in particular, to a two-level security LED light with motion sensor.

2. Description of Related Art

Lighting sources such as the fluorescent lamps, the incandescent lamps, the halogen lamps, and the light-emitting diodes (LED) are commonly found in lighting apparatuses for illumination purpose. Photo resistors are often utilized in outdoor lighting applications for automatic illuminations, known as the Photo-Control (PC) mode. Timers may be used in the PC mode for turning off the illumination or for switching to a lower level illumination of a lighting source after the lighting source having delivered a high level illumination for a predetermined duration, referred as the Power-Saving (PS) mode. Motion sensors are often used in the lighting apparatus for delivering full-power illumination thereof for a short duration when a human motion is detected, then switching back to the PS mode. Illumination operation controls such as auto-illumination in accordance to the background brightness detection, illumination using timer, illumination operation control using motion sensing results (e.g., dark or low luminous power to fully illuminated), and brightness control are often implemented by complex circuitries. In particular, the design and construction of LED drivers are still of a complex technology with high fabrication cost.

Therefore, how to develop a simple and effective design method on illumination controls such as enhancing contrast in illumination and color temperature for various types lighting sources, especially the controls for LEDs are the topics of the present disclosure.

SUMMARY

An exemplary embodiment of the present disclosure provides a two-level LED security light with motion sensor which may switch to high level illumination in the Power-Saving (PS) mode for a predetermined duration time when a human motion is detected thereby achieve warning purpose using method of electric current or lighting load adjustment. Furthermore, prior to the detection of an intrusion, the LED security light may be constantly in the low level illumination to save energy.

An exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit further includes one or a plurality of series-connected LEDs; when the light sensing control unit detects that an ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a high level or a low level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit increases the electric current that flows through the light-emitting unit so as to generate the high level illumination for a predetermined duration.

Another exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, a light-emitting unit. The light-emitting unit includes a plurality of series-connected LEDs. When the light sensing control unit detects that an ambient light is lower than a predetermined value, the loading and power control unit turns on a portion or all the LEDs of the light-emitting unit to generate a low level or a high level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off all the LEDs in the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit turns on a plurality of LEDs in the light-emitting unit and generates the high level illumination for a predetermine duration. An electric current control circuit is integrated in the exemplary embodiment for providing constant electric current to drive the LEDS in the light-emitting unit.

One exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes one or a plurality of parallel-connected alternating current (AC) LEDs. A phase controller is coupled between the described one or a plurality parallel-connected ACLEDs and AC power source. The loading and power control unit may through the phase controller control the average power of the light-emitting unit; when the light sensing control unit detects that an ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a high level or a lower level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit increases the average power of the light-emitting unit thereby generates the high level illumination for a predetermine duration.

According to an exemplary embodiment of the present disclosure, a two-level LED security light includes a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes X high wattage ACLEDs and Y low wattage ACLEDs connected in parallel. When the light sensing control unit detects that an ambient light is lower than a predetermined value, the loading and power control unit turns on the plurality of low wattage ACLEDs to generate a low level illumination; when the light sensing control unit detects that the ambient light is higher

than a predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensor detects an intrusion, the loading and power control unit turns on both the high wattage ACLEDs and the low wattage ACLEDs at same time thereby generates a high level illumination for a predetermine duration, wherein X and Y are of positive integers.

According to an exemplary embodiment of the present disclosure, a two-level LED security light with motion sensor includes a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes a rectifier circuit connected between one or a plurality of parallel-connected AC lighting sources and AC power source. The loading and power control unit may through the rectifier circuit adjust the average power of the light-emitting unit. When the light sensing control unit detects that an ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a low level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects an intrusion, the loading and power control unit increases the average power of the light-emitting unit thereby generates a high level illumination for a predetermine duration. The rectifier circuit includes a switch parallel-connected with a diode, wherein the switch is controlled by the loading and power control unit.

To sum up, a two-level LED security light with motion sensor provided by an exemplary embodiment in the preset disclosure, may execute Photo-Control (PC) and Power-Saving (PS) modes. When operates in the PC mode, the lighting apparatus may auto-illuminate at night and auto turn off at dawn. The PC mode may generate a high level illumination for a predetermined duration then automatically switch to the PS mode by a control unit to generate a low level illumination. When the motion sensor detects a human motion, the disclosed LED security light may immediately switch to the high level illumination for a short predetermined duration thereby achieve illumination or warning effect. After the short predetermined duration, the LED security light may automatically return to the low level illumination for saving energy. The PC mode may alternatively generate the low level illumination to begin with and when the motion sensor is detected the disclosed LED security may immediately switch to a high level illumination for a short predetermined duration to provide security protection and then automatically return to the low level illumination.

In order to further understand the techniques, means and effects of the present disclosure, the following detailed descriptions and appended drawings are hereby referred, such that, through which, the purposes, features and aspects of the present disclosure can be thoroughly and concretely appreciated; however, the appended drawings are merely provided for reference and illustration, without any intention to be used for limiting the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the present disclosure, and are incorporated in and constitute a part of this specification. The drawings illustrate exemplary embodiments of the present disclosure and, together with the description, serve to explain the principles of the present disclosure.

FIG. **1** schematically illustrates a block diagram of a two-level LED security light in accordance with an exemplary embodiment of the present disclosure.

FIG. **1**A is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for an ACLED two-level security light, wherein the loading and power comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises a bidirectional semiconductor switching device for controlling an average electric power to be delivered to the ACLED.

FIG. **1**B is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for a DC LED two level security light, wherein the loading and power control unit comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises an unidirectional semiconductor switching device for controlling an average electric power to be delivered to the DC LED.

FIG. **2**A illustrates a schematic diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure.

FIG. **2**B graphically illustrates a timing waveform of a pulse width modulation (PWM) signal in accordance to the first exemplary embodiment of the present disclosure.

FIG. **3**A illustrates a schematic diagram of a two-level LED security light in accordance to the second exemplary embodiment of the present disclosure.

FIG. **3**B illustrates a schematic diagram of a two-level LED security light in accordance to the second exemplary embodiment of the present disclosure.

FIG. **4**A illustrates a schematic diagram of a two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **4**B illustrates a timing waveform of two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **5** illustrates a schematic diagram of a two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **6** illustrates a schematic diagram of a two-level LED security light in accordance to the fourth exemplary embodiment of the present disclosure.

FIG. **7** illustrates a schematic diagram of a two-level LED security light in accordance to the fifth exemplary embodiment of the present disclosure.

FIGS. **8**A, **8**B, **8**C, and **8**D schematically and respectively show V-I relationship charts (Forward Current vs. Forward Voltage) for a white LED chip from each of 4 different LED manufacturers.

FIG. **9** is a data sheet showing data of the minimum forward voltages and maximum forward voltages collected from various LED manufacturers.

DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

Reference is made in detail to the exemplary embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or alike parts.

First Exemplary Embodiment

Refer to FIG. **1**, which schematically illustrates a block diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure. A

two-level LED security light (herein as the lighting apparatus) **100** includes a power supply unit **110**, a light sensing control unit **120**, a motion sensing unit **130**, a loading and power control unit **140**, and a light-emitting unit **150**. The power supply unit **110** is used for supplying power required to operate the system, wherein the associated structure includes the known AC/DC voltage converter. The light sensing control unit **120** may be a photoresistor, which may be coupled to the loading and power control unit **140** for determining daytime or nighttime in accordance to the ambient light. The motion sensing unit **130** may be a passive infrared sensor (PIR), which is coupled to the loading and power control unit **140** and is used to detect intrusions. When a person is entering a predetermined detection zone of the motion sensing unit **130**, a sensing signal thereof may be transmitted to the loading and power control unit **140**.

The loading and power control unit **140** which is coupled to the light-emitting unit **150** may be implemented by a microcontroller electrically coupled with a switching circuitry electrically connected between the light emitting unit **150** and the power supply unit **110**. The switching circuitry may comprise a plurality of semiconductor switching components. The loading and power control unit **140** may control the illumination levels of the light-emitting unit **150** in accordance to the sensing signal outputted by the light sensing control unit **120** and the motion sensing unit **130**. The light-emitting unit **150** may include a plurality of LEDs. The loading and power control unit **140** may control the light-emitting unit **150** to generate at least two levels of illumination variations.

When the light sensing control unit **120** detects that an ambient light is lower than a predetermined value (i.e., nighttime), the loading and power control unit **140** executes the Photo-Control (PC) mode by turning on the light-emitting unit **150** to generate a high level illumination for a predetermined duration then return to a low level illumination for Power-Saving (PS) mode or it may alternatively generate the low level illumination to perform the power saving mode. When the light sensing control unit **120** detects that the ambient light is higher than a predetermined value (i.e., dawn), the loading and power control unit **140** turns off the light-emitting unit **150**. In the PS mode, when the motion sensing unit **130** detects a human motion, the loading and power control unit **140** may increase the electric current which flows through the light-emitting unit **150**, to generate another high level illumination for a short predetermined duration. After the short predetermined duration, the loading and power control unit **140** may automatically lower the electric current that flow through the light-emitting unit **150** thus have the light-emitting unit **150** return to low level illumination for saving energy.

Refer to **2**A, which illustrates a schematic diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure. The light sensing control unit **120** may be implemented by a light sensor **220**; the motion sensing unit **130** may be implemented by a motion sensor **230**; the loading and power control unit **140** may be implemented by a microcontroller **240** electrically coupled to a switching circuitry **Q1**. The light-emitting unit **250** includes three series-connected LEDs **L1**~**L3**. The LEDs **L1**~**L3** is connected between a DC source and a transistor **Q1**, wherein the DC source may be provided by the power supply unit **110**. The transistor **Q1** may be an N-channel metal-oxide-semiconductor field-effect-transistor (NMOS). The transistor **Q1** is connected between the three series-connected LEDs **L1**~**L3** and a ground GND. The loading and power control unit **140** implemented by the microcontroller **240** may output a control signal like a pulse width modulation (PWM) signal to control an average electric current delivered to the light emitting unit **250**. It is worth to note that the electric components depicted in FIG. **2**A only serves as an illustration for the exemplary embodiment of the present disclose and hence the present disclosure is not limited thereto.

Refer to FIG. **2**B concurrently, which graphically illustrates a timing waveform of a pulse width modulation (PWM) signal in accordance to the first exemplary embodiment of the present disclosure. In the PC mode, the PWM signal may be used to configure the transistor **Q1** to have the conduction period T_{on} being longer than the cut-off period T_{off}. On the other hand in the PS mode, the PWM signal may configure the transistor **Q1** to have the conduction period T_{on} being shorter than the cut-off period T_{off}. In comparison of the illumination levels between the PC and PS modes, as the conduction period T_{on} of transistor **Q1** being longer under the PC mode, therefore have higher average electric current driving the light-emitting unit **250** thereby generate high illumination, which may be classified as the high level illumination; whereas as the conduction period T_{on} of transistor **Q1** is shorter in the PS mode, therefore have lower average electric current driving the light-emitting unit **250** thereby generate low illumination, which may be classified as the low level illumination.

The microcontroller **240** turns off the light-emitting unit **250** during the day and activates the PC mode at night by turning on the light-emitting unit **250** to generate the high level illumination for a short predetermined duration then return to the low level illumination thereby entering the PS mode. When the motion sensor **230** detects a human motion in the PS mode, the light-emitting unit **250** may switch to the high level illumination for illumination or warning application. The light-emitting unit **250** may return to the low level illumination after maintaining at the high level illumination for a short predetermined duration to save energy.

In addition, the microcontroller **240** is coupled to a time setting unit **260**, wherein the time setting unit **260** may allow a user to configure the predetermined duration associated with the high level illumination in the PC mode, however the present disclosure is not limited thereto. The time setting unit **260** may also be used for setting a predetermined time duration associated with the low level illumination as well as a predetermined time duration associated with a motion activated high level illumination. The time setting unit **260** is typically configured with an analogue circuitry comprising a resister and a capacitor for setting a time length. However, if precision of time length is crucial or much preferred, a digital circuitry may be employed, wherein a voltage divider with a variable resister coupled to the microcontroller designed with a time setting subroutine or a push button device coupled with a grounding pin of the microcontroller designed with the time setting subroutine for more precisely setting a time length for performing an illumination mode.

Second Exemplary Embodiment

Refer again to FIG. **1**, wherein the illumination variations of the light-emitting unit **150** may be implemented through the number of light-source loads being turned on to generate more than two levels of illumination. The lighting apparatus **100** in the instant exemplary embodiment may be through turning on a portion of LEDs or all the LEDs to generate a low and a high level of illuminations.

Refer to FIG. **3**A concurrently, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the second exemplary embodiment of the present disclosure. The main difference between FIG. **3**A and FIG. **2**A is in the light-emitting unit **350**, having three series-connected LEDs L**1**~L**3** and NMOS transistors Q**1** and Q**2**. The LEDs L**1**~L**3** are series connected to the transistor Q**1** at same time connected between the DC source and a constant electric current control circuit **310**. Moreover, transistor Q**2** is parallel connected to the two ends associated with LEDs L**2** and L**3**. The gates of the transistors Q**1** and Q**2** are connected respectively to a pin PC and a pin PS of the microcontroller **240**. The constant electric current control circuit **310** in the instant exemplary embodiment maintains the electric current in the activated LED at a constant value, namely, the LEDs L**1**~L**3** are operated in constant-current mode.

Refer to FIG. **3**A, the pin PC of the microcontroller **240** controls the switching operations of the transistor Q**1**; when the voltage level of pin PC being either a high voltage or a low voltage, the transistor Q**1** may conduct or cut-off, respectively, to turn the LEDs L**1**~L**3** on or off. The pin PS of the microcontroller **240** controls the switch operations of the transistor Q**2**, to form two current paths **351** and **352** on the light-emitting unit **350**. When the voltage at the pin PS of the microcontroller **240** is high, the transistor Q**2** conducts, thereby forming the current path **351** passing through the LED L**1** and the transistor Q**2**; when the voltage at the pin PS being low, the transistor Q**2** cuts-off, thereby forming the current path **352** passing through all the LEDs L**1**~L**3**. The microcontroller **240** may then control the switching operation of the transistor Q**2** to turn on the desired number of LEDs so as to generate a high or a low level illumination.

When light sensor **220** determines that an ambient light is higher than a predetermined value, the microcontroller **240** through the pin PC outputs a low voltage, which causes the transistor Q**1** to cut-off and turns off all the LEDs L**1**~L**3** in the light-emitting unit **350**. Conversely, when the light sensor **220** detects that the ambient light is lower than the predetermined value, the microcontroller **240** activates the PC mode, i.e., outputting a high voltage from pin PC and a low voltage from pin PS, to activate the transistor Q**1** while cut-off the transistor Q**2**, thereby forming the current path **352**, to turn on the three LEDs L**1**~L**3** in the light-emitting unit **350** so as to generate the high level illumination for a predetermined duration. After the predetermined duration, the microcontroller **240** may switch to the PS mode by having the pin PC continue outputting a high voltage and the pin PS outputting a high voltage, to have the transistor Q**2** conducts, thereby forming the current path **351**. Consequently, only the LED L**1** is turned on and the low level illumination is generated.

When the motion sensor detects a human motion in the PS mode, the pin PS of the microcontroller **240** temporarily switches from the high voltage to a low voltage, to have the transistor Q**2** temporarily cuts-off thus forming the current path **352** to activate all the LEDs in the light-emitting unit **350**, thereby temporarily generates the high level illumination. The light-emitting unit **350** is driven by a constant electric current, therefore the illumination level generated thereof is directly proportional to the number of LEDs activated. FIG. **3**B illustrates another implementation for FIG. **3**A, wherein the relays J**1** and J**2** are used in place of NMOS transistors to serve as switches. The microcontroller **240** may control the relays J**2** and J**1** through regulating the switching operations of the NPN bipolar junction transistors Q**4** and Q**5**. Moreover, resistors R**16** and R**17** are current-limiting resistors.

In the PC mode, the relay J**1** being pull-in while the relay J**2** bounce off to have constant electric current driving all the LEDs L**1**~L**3** to generate the high level illumination; in PS mode, the relays J**1** and J**2** both pull-in to have constant electric current only driving the LED L**1** thus the low level illumination may be thereby generated. Furthermore, when the motion sensor **230** detects a human motion, the pin PS of the microcontroller **240** may temporarily switch from high voltage to low voltage, forcing the relay J**2** to temporarily bounce off and the relay J**1** pull-in so as to temporarily generate the high level illumination.

The LED L**1** may adopt a LED having color temperature of 2700K while the LEDs L**2** and L**3** may adopt LEDs having color temperature of 5000K in order to increase the contrast between the high level and the low level illuminations. The number of LEDs included in the light-emitting unit **350** may be more than three, for example five or six LEDs. The transistor Q**2** may be relatively parallel to the two ends associated with a plurality of LEDs to adjust the illumination difference between the high and the low illumination levels. Additionally, the light-emitting unit **350** may be connected to a plurality of transistors Q**2**, which are respectively coupled to the two ends associated with each LED to provide more lighting variation selections. The microcontroller **240** may decide the number of LEDs to turn on in accordance to design needs at different conditions. Based on the explanation of the aforementioned exemplary embodiment, those skills in the art should be able to deduce other implementation and further descriptions are therefore omitted.

Third Exemplary Embodiment

Refer back to FIG. **1**, wherein the light-emitting unit **150** may include one or more parallel-connected alternating current (AC) LEDs. A phase controller is coupled between the described one or more parallel-connected ACLEDs and AC power source. The loading and power controller **140** in the instant exemplary embodiment may through the phase controller adjust the average power of the light-emitting unit **150** so as to generate variations in the low level and the high level illuminations.

Refer to FIG. **4**A, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the third exemplary embodiment of the present disclosure. The main difference between FIG. **4**A and FIG. **3** is in that the light-source load is an ACLED, which is coupled to the AC power source, and further the light-emitting unit **450** is connected to a phase controller **451**. The phase controller **451** includes a bi-directional switching device **452**, here, a triac, a zero-crossing detection circuit **453**, and a resistor R. The microcontroller **240** turns off the light-emitting unit **450** when the light sensor **220** detects that the ambient light is higher than a predetermined value. Conversely, when the light sensor **220** detects that the ambient light is lower than the predetermined value, the microcontroller **240** activates the PC mode by turning on the light-emitting unit **450**. In the PC mode, the microcontroller **240** may select a control pin for outputting a pulse signal which through a resistor R triggers the triac **452** to have a large conduction angle. The large conduction angle configures the light-emitting unit **450** to generate a high level illumination for a predetermined duration. Then the microcontroller **240** outputs the pulse signal for PS mode through the same control pin to trigger

the triac **452** to have a small conduction angle for switching the light-emitting unit **450** from the high level illumination to the low level illumination of the PS mode. Moreover, when the motion sensor **230** (also called motion sensing unit) detects a human motion in the PS mode, the microcontroller **240** temporarily outputs the PC-mode pulse signal through the same control pin to have the light-emitting unit **450** generated the high level illumination for a short predetermined duration. After the short predetermined duration, the light-emitting unit **450** returns to the low level illumination.

In the illumination control of the ACLED, the microcontroller **240** may utilize the detected zero-crossing time (e.g., the zero-crossing time of an AC voltage waveform) outputted from the zero-crossing detection circuit **453** to send an AC synchronized pulse signal thereof which may trigger the triac **452** of the phase controller **451** thereby to change the average power input to the light-emitting unit **450**. As the ACLED has a cut-in voltage V_t for start conducting, thus if the pulse signal inaccurately in time triggers the conduction of the triac **452**, then the instantaneous value of AC voltage may be lower than the cut-in voltage V_t of ACLED at the trigger pulse. Consequently, the ACLED may result in the phenomenon of either flashing or not turning on. Therefore, the pulse signal generated by the microcontroller **240** must fall in a proper time gap behind the zero-crossing point associated with the AC sinusoidal voltage waveform.

Supposing an AC power source having a voltage amplitude V_m and frequency f, then the zero-crossing time gap t_D of the trigger pulse outputted by the microcontroller **240** should be limited according to $t_o<t_D<½_f-t_o$ for a light-source load with a cut-in voltage V_t, wherein $t_o=(½\pi f)\sin^{-1}(V_t/V_m)$. The described criterion is applicable to all types of ACLEDs to assure that the triac **452** can be stably triggered in both positive and negative half cycle of the AC power source. Take ACLED with V_t(rms)=80V as an example, and supposing the V_m(rms)=110V and f=60 Hz, then t_o=2.2 ms and (½f)=8.3 ms may be obtained. Consequently, the proper zero-crossing time gap t_D associated with the phase modulation pulse outputted by the microcontroller **240** which lagged the AC sinusoidal voltage waveform should be designed in the range of 2.2 ms<t_D, <6.1 ms.

Refer to FIG. **4**B, which illustrates a timing waveform of the two-level LED security light in accordance to the third exemplary embodiment of the present disclosure. Waveforms (a)~(d) of FIG. **4**B respectively represent the AC power source, the output of the zero-crossing detection circuit **453**, the zero-crossing delay pulse at the control pin of the microcontroller **240**, and the voltage waveform across the two ends of the ACLED in the light-emitting unit **450**. The zero-crossing detection circuit **453** converts the AC voltage sinusoidal waveform associated with the AC power source to a symmetric square waveform having a low and a high voltage levels as shown in FIG. **4**B(b). At the zero-crossing point of the AC voltage sinusoidal wave, the symmetric square waveform may transit either from the low voltage level to the high voltage level or from the high voltage level to the low voltage level. Or equivalently, the edge of the symmetric square waveform in the time domain corresponds to the zero-crossing point of the AC voltage sinusoidal waveform. As shown in FIG. **4**B(c), the microcontroller **240** outputs a zero-crossing delay pulse in correspondence to the zero-crossing point of the AC sinusoidal waveform in accordance to the output waveform of the zero-crossing detection circuit **453**. The zero-crossing delay pulse is relative to an edge of symmetric square waveform behind a time gap t_D in the time domain. The t_D should fall in a valid range, as described previously, to assure that the triac **452** can be stably triggered thereby to turn on the ACLED. FIG. **4**B(d) illustrates a voltage waveform applied across the two ends associated with the ACLED. The illumination level of the light-emitting unit **450** is related to the conduction period t_{on} of the ACLED, or equivalently, the length t_{on} is directly proportional to the average power inputted to the ACLED. The difference between the PC mode and the PS mode being that in the PC mode, the ACLED has longer conduction period, thereby generates the high level illumination; whereas in the PS mode, the ACLED conduction period is shorter, hence generates the low level illumination.

Refer to FIG. **5**, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the third exemplary embodiment of the present disclosure. The light-emitting unit **550** of the lighting apparatus **100** includes an ACLED**1**, an ACLED**2**. The phase controller **551** includes triacs **552** and **553**, the zero-crossing detection circuit **554** as well as resistors R**1** and R**2**. The light-emitting unit **550** of FIG. **5** is different from the light-emitting unit **450** of FIG. **4** in that the light-emitting unit **550** has more than one ACLED and more than one bi-directional switching device. Furthermore, the color temperatures of the ACLED**1** and the ACLED**2** may be selected to be different.

In the exemplary embodiment of FIG. **5**, the ACLED**1** has a high color temperature, and the ACLED**2** has a low color temperature. In the PC mode, the microcontroller **240** uses the phase controller **551** to trigger both ACLED**1** and ACLED**2** to conduct for a long period, thereby to generate the high level illumination as well as illumination of mix color temperature. In the PS mode, the microcontroller **240** uses the phase controller **551** to trigger only the ACLED**2** to conduct for a short period, thereby generates the low level illumination as well as illumination of low color temperature. Moreover, in the PS mode, when the motion sensor **230** detects a human motion, the microcontroller **240** may through the phase controller **551** trigger the ACLED**1** and ACLED**2** to conduct for a long period. Thereby, it may render the light-emitting unit **450** to generate the high level illumination of high color temperature and to produce high contrast in illumination and hue, for a short predetermined duration to warn the intruder. Consequently, the lighting apparatus may generate the high level or the low level illumination of different hue. The rest of operation theories associated with the light-emitting unit **550** are essentially the same as the light-emitting unit **450** and further descriptions are therefore omitted.

Fourth Exemplary Embodiment

Refer to FIG. **6**, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the fourth exemplary embodiment of the present disclosure. The light-emitting unit **150** of FIG. **1** may be implemented by the light-emitting unit **650**, wherein the light-emitting unit **650** includes three ACLED**1**~**3** having identical luminous power electrically connected to switches **651** and **652**. In which, switches **651** and **652** may be relays. The parallel-connected ACLED**1** and ACLED**2** are series-connected to the switch **652** to produce double luminous power, and of which the ACLED**3** is parallel connected to, to generate triple luminous power, and of which an AC power source is further coupled to through the switch **651**. Moreover, the microcontroller **240** implements the loading and power control unit **140** of FIG. **1**. The pin PC and pin PS are respectively

connected to switches **651** and **652** for outputting voltage signals to control the operations of switches **651** and **652** (i.e., open or close).

In the PC mode, the pin PC and pin PS of the microcontroller **240** control the switches **651** and **652** to be closed at same time. Consequently, the ACLED**1~3** are coupled to the AC power source and the light-emitting unit **650** may generate a high level illumination of triple luminous power. After a short predetermined duration, the microcontroller **240** returns to PS mode. In which the switch **651** is closed while the pin PS controls the switch **652** to be opened, consequently, only the ACLED**3** is connected to AC power source, and the light-emitting unit **650** may thus generate the low level illumination of one luminous power. In the PS mode, when the motion sensor **230** detects a human motion, the microcontroller **240** temporarily closes the switch **652** to generate high level illumination with triple luminous power for a predetermined duration. After the predetermined duration, the switch **652** returns to open status thereby to generate the low level illumination of one luminous power. The lighting apparatus of FIG. **6** may therefore through controlling switches **651** and **652** generate two level illuminations with illumination contrast of at least 3 to 1.

The ACLED**1** and ACLED**2** of FIG. **6** may be high power lighting sources having color temperature of 5000K. The ACLED**3** may be a low power lighting source having color temperature of 2700K. Consequently, the ACLED may generate two levels of illuminations with high illumination and hue contrast without using a zero-crossing detection circuit.

Fifth Exemplary Embodiment

Refer to FIG. **7**, which illustrates a schematic diagram of a two-level LED security light in accordance to the fifth exemplary embodiment of the present disclosure. The light-emitting unit **750** of FIG. **7** is different from the light-emitting unit **640** of FIG. **6** in that the ACLED**3** is series-connected to a circuit with a rectified diode D and a switch **753** parallel-connected together, and of which is further coupled through a switch **751** to AC power source. When the switch **753** closes, the AC electric current that passes through the ACLED**3** may be a full sinusoidal waveform. When the switch **753** opens, the rectified diode rectifies the AC power, thus only one half cycle of the AC electric current may pass through the ACLED, consequently the luminous power of ALCED**3** is cut to be half.

The pin PS of the microcontroller **240** synchronously controls the operations of switches **752** and **753**. If the three ACLED**1~3** have identical luminous power, then in the PC mode, the pin PC and pin PS of the microcontroller **240** synchronously close the switches **751~753** to render ACLED**1~3** illuminating, thus the light-emitting unit **750** generates a high level illumination which is three-times higher than the luminous power of a single ACLED. When in the PS mode, the microcontroller **240** closes the switch **751** while opens switches **752** and **753**. At this moment, only the ACLED**3** illuminates and as the AC power source is rectified by the rectified diode D, thus the luminous power of ACLED**3** is half of the AC power source prior to the rectification. The luminous power ratio between the high level and the low level illuminations is therefore 6 to 1. Consequently, strong illumination contrast may be generated to effectively warn the intruder.

It should be noted that the light-emitting unit in the fifth exemplary embodiment is not limited to utilizing ACLEDs. In other words, the light-emitting unit may include any AC lighting sources such as ACLEDs, incandescent lamps, or fluorescent lamps.

When the light source of the light emitting unit **150** is confined to the use of an LED load, the compliance and satisfaction of an operating constraint attributable to the unique electrical characteristics of the LED load is vital to a successful performance of an LED lighting device. Any LED lighting device failing to comply with the operating constraint of the unique electrical characteristics is bound to become a trouble art. This is because the LED as a kind of solid state light source has completely different electrical characteristics for performing light emission compared with conventional light source such as incandescent bulbs or fluorescent bulbs. For instance, for a white light or blue light LED there exists a very narrow voltage domain ranging from a minimum threshold voltage at 2.5 volts to a maximum working voltage at 3.3 volts, which allows to operate adequately and safely the LED; in other words, when a forward voltage imposed on the LED is lower than the minimum threshold voltage, the LED is not conducted and therefore no light is emitted, when the forward voltage exceeds the maximum working voltage, the heat generated by a forward current could start damaging the construction of the LED. Therefore, the forward voltage imposed on the LED is required to operate between the minimum threshold voltage and the maximum working voltage. In respect to the LED load of the light-emitting unit **150**, the cut-in voltage V_t of ACLEDs is technically also referred to as a minimum threshold voltage attributable to PN junctions manufactured in LEDs. More specifically, the LED is made with a PN junction semiconductor structure inherently featured with three unique electrical characteristics, the first characteristic is one-way electric conduction through the PN junction fabricated in the LED, the second electrical characteristic is a minimum threshold voltage V_{th} required to trigger the LED to start emitting light and the third electrical characteristic is a maximum working voltage V_{max} allowed to impose on the LED to avoid a thermal runaway to damage or burn out the semiconductor construction of the LED. The described cut-in voltage V_t has the same meaning as the above mentioned minimum threshold voltage V_{th} which is a more general term to be used for describing the second electrical characteristic of a PN junction semiconductor structure. Also because the cut-in voltage V_t is specifically tied to forming a formula to transform the minimum threshold voltage into a corresponding time phase of AC power for lighting control, it is necessary to use the term V_{al} as a neutral word for describing the LED electrical characteristics to avoid being confused with the specific application for ACLED alone. Additionally, it is to be clarified that the term V_m is related to the amplitude of the instant maximum voltage of an AC power source which has nothing to do with the third electrical characteristic V_{max} of an LED load.

An LED chip is a small piece of semiconductor material with at least one LED manufactured inside the semiconductor material. A plurality of LEDs may be manufactured and packaged inside an LED chip for different levels of wattage specification to meet different illumination need. For each LED chip designed with a different level of wattage specification there always exists a narrow voltage domain $V_{th}<V<V_{max}$, wherein V_{th} is the minimum threshold voltage to enable the LED chip to start emitting light and V_{max} is the maximum working voltage allowed to impose on the LED chip to protect the LED chip from being damaged or burned out by the heat generated by a higher working voltage exceeding V_{max}.

For an LED load configured with a plurality of the LED chips in any LED lighting device, regardless such LED load being configured with ACLED chips or DC LED chips, the working voltage of each single LED chip is required to operate in a domain between a minimum threshold voltage V_{th} and a maximum working voltage V_{max} or $V_{th}<V<V_{max}$ and the working voltage of the LED load comprising N pieces of LED chips connected in series is therefore required to operate in a domain established by a minimum threshold voltage $N\times V_{th}$ and a maximum working voltage $N\times V_{max}$ or $N\times V_{th}<V<N\times V_{max}$ wherein N is the number of the LED chips electrically connected in series. For any LED lighting device comprising an LED load it is required that the LED load in conjunction with an adequate level of power source is configured with a combination of in series and in parallel connections of LED chips such that the electric current passing through each LED chip of the LED load remains at an adequate level such that a voltage V across each LED chip complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED chip or a voltage V across the LED load configured with N number of LED chips connected in series complies with an operating constraint of $N\times V_{th}<V<N\times V_{max}$. Such narrow operating range therefore posts an engineering challenge for a circuit designer to successfully design an adequate level of power source and a reliable circuitry configured with an adequate combination of in series connection and in parallel connection of LED chips for operating a higher power LED security light.

FIGS. **8**A, **8**B, **8**C and **8**D comprises 4 drawings schematically and respectively showing a V-I relationship chart (Forward Current vs. Forward Voltage) for a white light LED chip from each of 4 different LED manufacturers; as can be seen from the chart when a forward voltage V is below a minimum forward voltage at around 2.5 volts, the LED chip is not conducted so the current I is zero, as the forward voltage exceeds 2.5 volts the LED chip is activated to generate a current flow to emit light, as the forward voltage continues to increase, the current I increases exponentially at a much faster pace, at a maximum forward voltage around 3.3 volts the current I becomes 250 mA which generates a heat that could start damaging the PN junction of the LED chip. The minimum forward voltage (the minimum threshold voltage or cut-in voltage) and the maximum forward voltage are readily available in the specification sheets at each of LED manufacturers, such as Cree, Lumileds, Samsung, Osram, and etc. Different LED manufacturers may have slightly different figures due to manufacturing process but the deviations of differences are negligible. The constraints of minimum forward voltage and maximum forward voltage represent physical properties inherent in any solid state light source. They are necessary matter for configuring any LED lighting products to ensure a normal performance of an LED load.

FIG. **9** is a data sheet showing data of the minimum forward voltages and maximum forward voltages collected from various LED manufacturers. They are fundamental requirements for configuring any LED lighting control devices to ensure a successful performance of any LED lighting device.

In summary, the compliance of voltage operating constraint $V_{th}<V<V_{max}$ featuring electrical characteristics of an LED chip is a critical technology for ensuring a normal performance of the LED load. Failing to comply with such voltage operating constraint can quickly age or seriously damage the semiconductor structure of the LED chip with a consequence of quick lumens depreciation of the LED bulbs and the product lifetime being substantially shortened, which will be unacceptable to the consumers.

The compliance of the operating constraint $V_{th}<V<V_{max}$ is a necessary matter for any LED lighting device though it is not an obvious matter as it requires complicated technologies to calculate and coordinate among an adequate level of power source, a control circuitry- and a non-linear light emitting load. For conventional lighting load such as incandescent bulb there exists no such operating constraint. This is why in the past years there had been many consumers complaining about malfunction of LED bulbs that the consumers were frustrated with the fast depreciation of lumens output and substantially shortened product lifetime of the LED bulbs purchased and used. A good example was a law suit case filed by the Federal Trade Commission on Sep. 7, 2010 (Case No. SACV10-01333 JVS) for a complaint against a leading lighting manufacturer (Light of America) for marketing deceptive LED lamps and making false claims with respect to the life time of their LED lamps and a huge amount of monetary relief was claimed with the Court in the complaint.

The present disclosure of a two-level LED security light provides a unique life-style lighting solution. The motivation of creating such life-style lighting solution has less to do with the energy saving aspect of the low level illumination mode because LED is already a very energy saving light source compared with the conventional incandescent light source. For instance, a 10-watt LED security light when operated at a low level at 30% illumination it only saves 7 watts, which is not as significant as a 100-watt incandescent bulb which can save as much as 70 watts when operated at 30% illumination for a low level mode. While it is always good to save some extra energy, it is however not the main incentives for developing the present invention; the life-style lighting solution of the present disclosure is featured with two innovations which meaningfully improve the exquisite tastes of living in the evening, the first innovation is the creation of an aesthetic scene for the outdoor living environment, wherein at dusk the LED security light is automatically turned on by the photo sensor to perform the low level illumination which is necessary for creating a soft and aesthetic night scene for the outdoor living area (such soft and aesthetic night view is not achievable by the high level illumination however), the second innovation is the creation of a navigation capacity similar to a light house effect for guiding people to safely move toward a destination in the outdoor living area without getting lost or encountering an accident. These two innovative functions coupled with the motion sensor to increase illumination when people enters into the short detection area makes the present invention a perfect life-style lighting solution for enjoying an exquisite taste of evening life.

A lighting apparatus may be implemented by integrating a plurality of LEDs with a microcontroller and various types of sensor components in the controlling circuit in accordance to the above described five exemplary embodiments. This lighting apparatus may automatically generate high level illumination when the ambient light detected is insufficient and time-switch to the low level illumination. In addition, when a person is entering the predetermined detection zone, the lighting apparatus may switch from the low level illumination to the high level illumination, to provide the person with sufficient illumination or to generate strong illumination and hue contrast for monitoring the intruder.

The above-mentioned descriptions represent merely the exemplary embodiment of the present disclosure, without any intention to limit the scope of the present disclosure

thereto. Various equivalent changes, alternations or modifications based on the claims of present disclosure are all consequently viewed as being embraced by the scope of the present disclosure.

What is claimed is:

1. A life-style LED security light, comprising:

a power supply unit;

a light-emitting unit, including an LED load configured with a plurality of LEDs;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit, including at least one motion sensor; and

a time setting unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, and the controller is electrically coupled with the switching circuitry;

wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the light-emitting unit;

wherein the switching circuitry comprises at least one unidirectional semiconductor switching device;

wherein the controller outputs control signals to control the switching circuitry for delivering different average electric currents from the power supply unit to drive the LED load of the light-emitting unit such that the light-emitting unit respectively generates illuminations of different light intensities for performing different illumination modes activated by the light sensing control unit, the motion sensing unit and the time setting unit;

wherein at dusk when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the light-emitting unit is turned on by the loading and power control unit activated by the light sensing control unit to perform a first illumination mode with a first level illumination and with the motion sensing unit being deactivated, and the first illumination mode continues for a first predetermined time duration;

wherein upon a maturity of the first predetermined time duration the loading and power control unit manages to decrease the average electric current delivered to the LED load of the light-emitting unit to perform a second illumination mode with a second level illumination for a second predetermined time duration, and at the same time the motion sensing unit is activated;

wherein when a motion signal is detected by the motion sensing unit, the loading and power control unit manages to increase the average electric current delivered to the LED load of the light-emitting unit to perform a third illumination mode with a third level illumination for a third predetermined time duration before being switched back to the second illumination mode;

wherein at dawn when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the loading and power control unit manages to switch off the light-emitting unit;

wherein the light intensity of the third illumination mode is higher than the light intensity of the second illumination mode;

wherein the time setting unit is used for adjusting and setting at least a time length of at least one of the first predetermined time duration, the second predetermined time duration and the third predetermined time duration;

wherein the power supply unit is an AC/DC power converter to convert AC power into DC power for operating the life-style LED security light, wherein the power source is a DC power from the power supply unit;

wherein the LED load in conjunction with the power source from the power supply unit is configured with an adequate combination of in series and in parallel connections of LEDs such that an electric current passing through each LED of the LED load remains at an adequate level, and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED load;

wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum voltage across each LED to avoid a thermal damage to the LED construction; and

wherein the controller comprises at least a programmable integrated circuit device or an application specific integrated circuit.

2. The life-style LED security light according to claim **1**, wherein when the LED load is configured with a plurality of LEDs or sets of LEDs electrically connected in series, a working voltage across the LED load is confined in a domain between a minimum voltage equal to the total sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the total sum of the maximum voltages of all LEDs or sets of LEDs electrically connected in series.

3. The life-style LED security light according to claim **1**, wherein the control signals are pulse width modulation (PWM) signals.

4. The life-style LED security light according to claim **1**, wherein the first predetermined time duration is programmable by the time setting unit.

5. The life-style LED security light according to claim **1**, wherein the light intensity of the first illumination mode is adjustable by an external control unit.

6. The life-style LED security light according to claim **1**, wherein the time length of the second predetermined duration is set to end at dawn activated by the light sensing control unit.

7. The life-style LED security light according to claim **1**, wherein the second predetermined duration is programmable by the time setting unit.

8. The life-style LED security light according to claim **1**, wherein the light intensity of the second illumination mode is adjustable by an external control unit.

9. The life-style LED security light according to claim **1**, wherein the motion sensor is a passive infrared sensor.

10. The life-style LED security light according to claim **1**, wherein the motion sensor is a microwave motion sensor or an ultrasonic motion sensor.

11. A life-style LED security light, comprising:

a power supply unit;

a light-emitting unit, including an LED load configured with a plurality of LEDs;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit, including at least one motion sensor; and

a time setting unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, and the controller is electrically coupled with the switching circuitry;

wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the light-emitting unit;

wherein the switching circuitry comprises at least one unidirectional semiconductor switching device;

wherein the controller outputs control signals to control the switching circuitry for delivering different average electric currents from the power supply unit to drive the LED load of the light-emitting unit such that the light-emitting unit respectively generates illuminations of different light intensities for performing different illumination modes activated by the light sensing control unit, the motion sensing unit and the time setting unit;

wherein at dusk when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the light-emitting unit is turned on by the loading and power control unit activated by the light sensing control unit to perform a first illumination mode with a first level illumination and with the motion sensing unit being in a deactivated state, and the first illumination mode continues for a first predetermined time duration;

wherein upon a maturity of the first predetermined time duration the loading and power control unit manages to cutoff the average electric current delivered to the LED load of the light-emitting unit and at the same time the motion sensing unit is activated;

wherein when a motion signal is detected by the motion sensing unit, the loading and power control unit manages to deliver the average electric current to the LED load of the light-emitting unit to perform a second illumination mode with a second level illumination for a second predetermined time duration before being switched back to the turned off state;

wherein at dawn when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the light-emitting unit is switched off by the loading and power control unit;

wherein the time setting unit is used for adjusting and setting at least a time length of at least one of the first predetermined time duration and the second predetermined time duration;

wherein the power supply unit is an AC/DC power converter to convert AC power into DC power for operating the life-style LED security light, wherein the power source is a DC power from the power supply unit;

wherein the LED load in conjunction with the power source from the power supply unit is designed with an adequate combination of in series and in parallel connections of LEDs such that an electric current passing through each LED of the LED load remains at an adequate level, and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED;

wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum voltage across each LED to avoid a thermal damage to LED construction; and

wherein the controller comprises at least a programmable integrated circuit device or an application specific integrated circuit.

12. The life-style LED security light according to claim **11**, wherein when the LED load is configured with a plurality of LEDs or sets of LEDs electrically connected in series, a working voltage across the LED load is confined in a domain between a minimum voltage equal to the total sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the total sum of the maximum voltages of all LEDs or sets of LEDs electrically connected in series.

13. The life-style LED security light according to claim **11**, wherein the control signals are pulse width modulation (PWM) signals.

14. The life-style LED security light according to claim **11**, wherein the time length of the first predetermined time duration is programmable by the time setting unit.

15. The life-style LED security light according to claim **11**, wherein the light intensity of the first illumination mode is adjustable by an external control unit.

16. The life-style LED security light according to claim **11**, wherein the time length of the second predetermined time duration is programmable by the time setting unit.

17. The life-style LED security light according to claim **11**, wherein the light intensity of the second illumination mode is adjustable by an external control unit.

18. The life-style LED security light according to claim **11**, wherein the motion sensor is a passive infrared sensor.

19. The life-style LED security light according to claim **11**, wherein the motion sensor is a microwave motion sensor or an ultrasonic motion sensor.

20. A life-style LED security light, comprising:

a power supply unit;

a light-emitting unit, including an LED load configured with a plurality of LEDs;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit, including at least one motion sensor; and

a time setting unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, and the controller is electrically coupled with the switching circuitry;

wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the light-emitting unit;

wherein the switching circuitry comprises at least one unidirectional semiconductor switching device;

wherein the controller outputs control signals to control the switching circuitry for delivering different average electric currents from the power supply unit to drive the LED load of the light-emitting unit such that the light-emitting unit respectively generates illuminations of different light intensities for performing different illumination modes activated by the light sensing control unit, the motion sensing unit and the time setting unit;

wherein at dusk when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit operates to turn on the light emitting unit to perform a low level illumination mode comprising at least a first level illumination for a first predetermined time duration;

wherein during the performance of the low level illumination mode, the low level illumination creates two life-style innovations for performing a life-style lighting solution, wherein a first innovation is the creation of an aesthetic night scene when people are outside of a detection area of the motion sensor, wherein a second innovation is the creation of a navigation capacity similar to a light house for guiding people to safely walk to a destination in an outdoor living area;

wherein when a motion signal is detected by the motion sensing unit, the loading and power control unit operates to increase the average electric current delivered to the LED load of the light-emitting unit to perform a high level illumination mode for a preset time period before being switched back to the low level illumination mode;

wherein the light intensity of the high level illumination mode is higher than the light intensity of the low level illumination mode;

wherein at dawn when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the light-emitting unit is switched off by the loading and power control unit;

wherein the time setting unit is used for adjusting and setting at least a time length of at least one of the first predetermined time duration of the low level illumination mode and the preset time period of the high level illumination mode;

wherein the power supply unit is an AC/DC power converter to convert AC power into DC power for operating the life-style LED security light, wherein the power source is a DC power from the power supply unit;

wherein the LED load in conjunction with an adequate level of the power source is designed with an adequate combination of in series and in parallel connections of LEDs such that an electric current passing through each LED of the LED load remains at an adequate level, and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED;

wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum voltage across each LED to avoid a thermal damage to LED construction; and

wherein the controller comprises at least a programmable integrated circuit device or an application specific integrated circuit.

21. The life-style LED security light according to claim **20**, wherein the low level illumination mode further comprises a second level illumination;

wherein upon a maturity of the first predetermined time duration, the loading and power control unit operates to further reduce the light intensity of the low level illumination mode to perform the second level illumination to end at dawn activated by the light sensing control unit.

22. The life-style LED security light according to claim **21**, wherein the light intensity of the second level illumination is set at zero.

23. The life-style LED security light according to claim **21**, wherein the maturity of the first predetermined time duration is set to end at a midnight time point.

24. The life-style LED security light according to claim **20**, wherein when the LED load is configured with a plurality of LEDs or sets of LEDs electrically connected in series, a working voltage across the LED load is confined in a domain between a minimum voltage equal to the total sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the total sum of the maximum voltages of all LEDs or sets of LEDs electrically connected in series.

25. The life-style LED security light according to claim **20**, wherein the control signals are pulse width modulation (PWM) signals.

26. The life-style LED security light according to claim **20**, wherein the motion sensor is a passive infrared sensor.

27. The life-style LED security light according to claim **20**, wherein the motion sensor is a microwave motion sensor or an ultrasonic motion sensor.

28. The life-style LED security light according to claim **20**, wherein the time length of the low level illumination mode is set to end at dawn activated by the light sensing control unit.

29. The life-style LED security light according to claim **20**, wherein the first predetermined time duration is programmable by the time setting unit.

30. The life-style LED security light according to claim **20**, wherein the time length of the preset time period is programmable by the time setting unit.

31. An LED security light, comprising:

a power supply unit;

a light-emitting unit, including an LED load configured with a plurality of LEDs;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit, including at least one motion sensor; and

a time setting unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, and the controller is electrically coupled with the switching circuitry;

wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the light-emitting unit;

wherein the switching circuitry comprises at least one unidirectional semiconductor switching device;

wherein the controller outputs control signals to control the switching circuitry for delivering different average electric currents from the power supply unit to drive the LED load of the light-emitting unit such that the light-emitting unit respectively generates illuminations of different light intensities for performing different illumination modes for respective predetermined time durations activated by the light sensing control unit, the motion sensing unit and the time setting unit;

wherein the time setting unit is used for adjusting and setting at least a time length of the predetermined time durations;

wherein the power supply unit is an AC/DC power converter to convert AC power into DC power for operating the life-style LED security light, wherein the power source is a DC power from the power supply unit;

wherein the LED load in conjunction with an adequate level of the power source is designed with an adequate combination of in series and in parallel connections of LEDs such that an electric current passing through each LED of the LED load remains at an adequate level, and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED;

wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum voltage across each LED to avoid a thermal damage to LED construction; and

wherein the controller comprises at least a programmable integrated circuit device or an application specific integrated circuit.

32. The life-style LED security light according to claim **31**, wherein at dusk when an ambient light detected by the

light sensing control unit is lower than a first predetermined value, the loading and power control unit operates to switch on the light-emitting unit;

wherein when a motion signal is detected by the motion sensing unit, the loading and power control unit manages to turn on the light-emitting unit thru a soft on process, wherein the controller successively outputs a series of control signals to gradually increase the average electric current to drive the LED load of the light-emitting unit to generate a high level illumination, and the high level illumination continues for a predetermined time duration;

wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the light-emitting unit is turned off by the controller.

33. The life-style LED security light according to claim **31**, wherein at dusk when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit operates to switch on the light-emitting unit;

wherein when a motion signal is detected by the motion sensing unit, the loading and power control unit manages to turn on the light-emitting unit to generate a high level illumination, the high level illumination continues for a predetermined time duration before the loading and power control unit manages to reduce illumination intensity of the light-emitting unit thru a soft off process, wherein the controller successively outputs a series of control signals to gradually decrease the average electric current to drive the LED load of the light-emitting unit such that the illumination intensity of the light-emitting unit is gradually reduced.

34. The life-style LED security light according to claim **31**, wherein at dusk when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the light-emitting unit is switched on by the loading and power control unit;

wherein when a motion signal is detected by the motion sensing unit, the loading and power control unit manages to turn on the light-emitting unit to perform a high level illumination for a predetermined time duration, wherein upon a maturity of the predetermined time duration the loading and power control unit manages to turn off the light-emitting unit that a soft off process, wherein the soft off process is designed with a two-stage approach;

wherein for the first stage of the soft off process, the loading and power control unit manages to instantly reduce the illumination level of the light-emitting unit to a low level illumination and continues the low level illumination for a first short time interval, wherein for the second stage of the soft off process the loading and power control unit operates to turn off the light-emitting unit.

35. The life-style LED security light according to claim **34**, wherein for the second stage of the soft off process the loading and power control unit operates to gradually turn off the illumination of the light-emitting unit over a second short time interval.

36. The life-style LED security light according to claim **34**, wherein during the soft off process if a new motion signal is further detected by the motion sensing unit indicating an occupant remaining in the detection area, the loading and power control unit instantly operates to restart a new cycle of the high level illumination for a new predetermined time duration;

wherein during the soft off a process if no further motion signal is received indicating the detection area is unoccupied, the light-emitting unit is thereby successfully turned, off.

37. The life-style LED security light according to claim **36**, wherein the new predetermined time duration is equal to the predetermined time duration used prior to restarting the new cycle of the high level illumination.

38. The life-style LED security light according to claim **36**, wherein the new predetermined time duration is programmed to be longer than the predetermined time duration used prior to restarting the new cycle of the high level illumination according to a programmed combination of increasing delay times.

39. The life-style LED security light according to claim **31**, wherein at dusk when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the light-emitting unit is switched on by the loading and power control unit;

wherein when a motion signal is detected by the motion sensing unit, the loading and power control unit manages to turn on the light-emitting unit to perform a high level illumination for a predetermined time duration, and upon a maturity of the predetermined time duration the loading and power control unit manages to turn off the light-emitting unit with a two-stage shutoff process;

wherein for the first stage of the shutoff process, the loading and power control unit manages to perform a sudden disruption of illumination for a short moment and resume instantly back to the high level illumination to continue for a first short time interval, wherein for the second stage of the shutoff process the loading and power control unit operates to gradually turn off the light-emitting unit over a second short time interval.

40. The life-style LED security light according to claim **39**, wherein during the two-stage shutoff process if a new motion signal is further detected by the motion sensing unit indicating an occupant remaining in the detection area, the loading and power control unit instantly manages to resume the high level illumination and restarts a new cycle of the high level illumination for a new predetermined time duration;

wherein during the two-stage shutoff process if no further motion signal is received indicating the detection area is unoccupied, the light-emitting unit is thereby successfully turned off.

41. The life-style LED security light according to claim **40**, wherein the time length of the new predetermined time duration is equal to the time length of the predetermined time duration.

42. The life-style LED security light according to claim **40**, wherein the time length of the new predetermined time duration is longer than the time length of the predetermined time duration according to a programmed combination of increasing delay times.

43. The life-style LED security light according to claim **31**, wherein at dusk when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the light-emitting unit is switched on by the loading and power control unit to generate a low level illumination;

wherein when a motion signal is detected by the motion sensing unit, the loading and power control unit manages to increase the average electric current from the power source to the LED load of the light-emitting unit to generate a high level illumination for a predetermined time duration, wherein upon a maturity of the predetermined time duration the loading and power

control unit manages the light-emitting unit to resume the low level illumination, wherein if a new motion signal is further detected by the motion sensing unit within a short predetermined time interval after the light-emitting unit being switched back to the low level illumination, the loading and power control unit instantly manages to resume the high level illumination and restart a new cycle of illumination for a new predetermined time duration, wherein the time length of the new predetermined time duration is longer than the time length of the predetermined time duration according to a programmed combination of increasing delay times.

44. The life-style LED security light according to claim **31**, wherein when the LED load is configured with a plurality of LEDs or sets of LEDs electrically connected in series, a working voltage across the LED load is confined in a domain between a minimum voltage equal to the total sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the total sum of the maximum voltages of all LEDs or sets of LEDs electrically connected in series.

45. The life-style LED security light according to claim **31**, wherein the control signals are pulse width modulation (PWM) signals.

46. The life-style LED security light according to claim **31**, wherein the motion sensor is a passive infrared sensor.

47. The life-style LED security light according to claim **31**, wherein the motion sensor is a microwave motion sensor or an ultrasonic motion sensor.

48. An LED security light, comprising:

a power supply unit;

a light-emitting unit, including an LED load configured with a plurality of LEDs;

a loading and power control unit;

a light sensing and control unit; and

a time setting unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the controller is electrically coupled with the switching circuitry, wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the light-emitting unit;

wherein with the switching circuitry the light-emitting unit is turned on or turned off by the loading and power control unit, and the switching circuitry comprises at least one unidirectional semiconductor switching device;

wherein the controller outputs control signals to control the switching circuitry for delivering different average electric currents from the power supply unit to drive the LED load of the light-emitting unit such that the light-emitting unit respectively generates illuminations of different light intensities for performing different illumination modes activated by the light sensing control unit and the time setting unit;

wherein at dusk when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the light-emitting unit is turned on by the loading and power control unit to perform a first illumination mode for a predetermined time duration set by the time setting unit, and then the controller manages to change the lighting performance of the LED security light from the first illumination mode to a second illumination mode;

wherein the light intensity of the second illumination mode is lower than the light intensity of the first illumination mode;

wherein at dawn when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the light-emitting unit is turned off by the controller;

wherein the time setting unit is used for adjusting and setting a time length of the predetermined time duration;

wherein the power supply unit is an AC/DC power converter to convert AC power into DC power for operating the LED security light, wherein the power source is a DC power from the power supply unit;

wherein the LED load in conjunction with an adequate level of the power source is designed with an adequate combination of in series and in parallel connections of LEDs such that an electric current passing through each LED of the LED load remains at an adequate level, and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED;

wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum voltage across each LED to avoid a thermal damage to LED construction; and

wherein the controller comprises at least a programmable integrated circuit device or an application specific integrated circuit.

49. The LED security light according to claim **48**, wherein when the LED load is configured with a plurality of LEDs or sets of LEDs electrically connected in series, a working voltage across the LED load is confined in a domain between a minimum voltage equal to the total sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the total sum of the maximum voltages of all LEDs or sets of LEDs electrically connected in series.

50. The LED security light according to claim **48**, wherein the control signals are pulse width modulation (PWM) signals.

51. An LED security light, comprising:

a power supply unit;

a light-emitting unit, including an LED load configured with a plurality of LEDs;

a loading and power control unit; and

a light sensing control unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the controller is electrically coupled with the switching circuitry, wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the LED load of the light-emitting unit;

wherein the switching circuitry comprises at least one unidirectional semiconductor switching device;

wherein at dusk when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the controller of the loading and power control unit outputs a control signal to conduct the switching circuitry to deliver an average electric current to the LED load to turn on the light-emitting unit for generating an illumination;

wherein at dawn when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the controller of the loading and power control unit outputs a control signal to cutoff the switching circuitry to turn off the light-emitting unit;

wherein the power supply unit is an AC/DC power converter to convert AC power into DC power for operating the LED security light, wherein the power source is a DC power from the power supply unit;

wherein the LED load in conjunction with an adequate level of the power source is designed, with an adequate combination of in series and in parallel connections of LEDs such that an electric current passing through each LED of the LED load remains at an adequate level, and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED;

wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum voltage across each LED to avoid a thermal damage to LED construction; and

wherein the controller comprises at least an integrated circuit device programmable for generating the control signals or an application specific integrated circuit customized for generating the control signals.

52. The LED security light according to claim **51**, wherein when the LED load is configured with a plurality of LEDs or sets of LEDs electrically connected in series, a working voltage across the LED load is confined in a domain between a minimum voltage equal to the total sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the total sum of the maximum voltages of all LEDs or sets of LEDs electrically connected in series.

53. An LED security light, comprising:

a power supply unit;

a light-emitting unit, including an LED load configured with a plurality of LEDs;

a loading and power control unit;

a light sensing control unit; and

an external control unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the controller is electrically coupled with the switching circuitry, wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the LED load of the light-emitting unit;

wherein the switching circuitry comprises at least one unidirectional semiconductor switching device, wherein the controller outputs control signals to control the switching circuitry for delivering different average electric currents from the power supply unit to drive the LED load of the light-emitting unit such that the light-emitting unit respectively generates illuminations of different light intensities for performing at least a first illumination mode and a second illumination mode activated by the light sensing control unit and the external control unit;

wherein the external control unit is a power interruption detection circuitry electrically coupled to the controller for detecting a short power interruption signal, wherein the controller controls the switching circuitry in response to the short power interruption signal detected to alternately switch the light-emitting unit between performing a first illumination mode and performing a second illumination mode, wherein the light intensity of the first illumination mode is higher than the light intensity of the second illumination mode;

wherein at dusk when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the light-emitting unit is turned on, by the loading and power control unit to perform the first illumination mode; wherein whenever the short power interruption signal is detected by the external control unit, the controller operates to alternately switch the light-emitting unit between performing the first illumination mode and performing the second illumination mode;

wherein at dawn when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the controller of the loading and power control unit operates to cutoff the switching circuitry to turn off the light-emitting unit;

wherein the power supply unit is an AC/DC power converter to convert AC power into DC power for operating the LED security light, wherein the power source is a DC power from the power supply unit;

wherein the LED load in conjunction with an adequate level of the power source is designed with an adequate combination of in series and in parallel connections of LEDs such that an electric current passing through each LED of the LED load remains at an adequate level, and a working voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED;

wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum voltage across each LED to avoid a thermal damage to LED construction; and

wherein the controller comprises at least an integrated circuit device programmable for generating the control signals or an application specific integrated circuit customized for generating the control signals.

54. The LED security light according to claim **53**, wherein when the LED load is configured with a plurality of LEDs or sets of LEDs electrically connected in series, a working voltage across the LED load is confined in a domain between a minimum voltage equal to the total sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the total sum of the maximum voltages of all LEDs or sets of LEDs electrically connected in series.

55. An LED motion sensing security light, comprising:

a power supply unit;

a light-emitting unit, including an LED load configured with a plurality of LEDs;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit, including at least one motion sensor; and

a time setting unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, and the controller is electrically coupled with the switching circuitry;

wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the light-emitting unit;

wherein the switching circuitry comprises at least one unidirectional semiconductor switching device;

wherein the controller outputs a control signal to control the switching circuitry for transmitting an average electric current from the power source to drive the LED load of the light-emitting unit to generate an illumination activated by the motion sensing unit for performing a motion sensing illumination mode;

wherein the power supply unit is an AC/DC power converter to convert AC power into DC power for operating the LED security light, wherein the power source is a DC power from the power supply unit;

wherein the LED load in conjunction with the power source is designed with an adequate combination of in series and in parallel connections of LEDs such that an electric current passing through each LED of the LED load remains at an adequate level, and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED;

wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum voltage across each LED to avoid a thermal damage to LED construction;

wherein at dusk when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit operates to switch on the light-emitting unit;

wherein when a motion signal is detected by the motion sensing unit, the loading and power control unit manages to conduct the switching circuitry to deliver the average electric current to drive the LED load for generating the illumination for a predetermined time duration preset by the time setting unit;

wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the light-emitting unit is turned off by the controller.

56. The LED motion sensing security light according to claim **55**, wherein when the LED load is configured with a plurality of LEDs or sets of LEDs electrically connected in series, a working voltage across the LED load is confined in a domain between a minimum voltage equal to the total sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the total sum of the maximum voltages of all LEDs or sets of LEDs electrically connected in series.

57. The LED security light according to claim **55**, wherein the control signal is pulse width modulation (PWM) signal.

58. The LED motion sensing security light according to claim **55**, wherein an external control unit is further installed and electrically coupled with the controller to receive and convert an external control signal into a message signal interpretable by the controller, wherein upon receiving the message signal the controller operates to activate a switching process to alternately perform among a high level non-motion sensing illumination mode, a low level non-motion sensing illumination mode and the motion sensing illumination mode.

59. The LED motion sensing security light according to claim **58**, wherein the external control unit is a short power interruption detection circuitry and the external control signal is an short power interruption signal, wherein when a first short power interruption signal is detected, the controller operates to change the performance of the light-emitting unit from the motion sensing illumination mode to the high level non-motion sensing illumination mode, wherein when a second short power interruption signal is furthered detected, the controller operates to change the performance of the light-emitting unit from the high level non-sensing illumination mode to the low level non-sensing illumination mode, wherein when a third short power interruption signal is further detected, the controller manages to change the performance of the light-emitting unit back to the motion sensing illumination mode to complete a cycle of the switching process.

60. The LED motion sensing security light according to claim **55**, wherein an external control unit is further installed and electrically coupled with the controller to receive and convert an external control signal into a message signal interpretable by the controller, wherein upon receiving the message signal the controller operates to activate a switching process to alternately perform between a low level non-motion sensing illumination mode and the motion sensing illumination mode.

61. The LED motion sensing security light according to claim **60**, wherein the external control unit is a short power interruption detection circuitry and the external control signal is a short power interruption signal, wherein when a first short power interruption signal is detected, the controller operates to change the performance of the light-emitting unit from the motion sensing illumination mode to the low level non-motion sensing illumination mode, wherein when a second short power interruption signal is furthered detected, the controller operates to change the performance of the light-emitting unit from the low level non-sensing illumination mode back to the motion sensing illumination mode to complete a cycle of the switching process.

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EXHIBIT C

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(12) **United States Patent**
Chen

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(54) **LIFESTYLE SECURITY LIGHT**

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See application file for complete search history.

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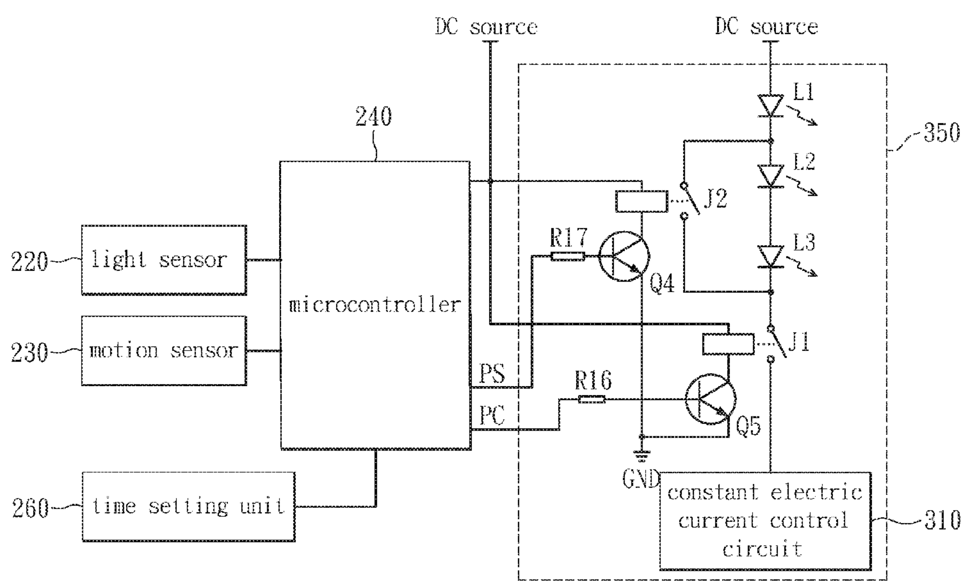
(57) **ABSTRACT**

A two-level LED security light includes a light-emitting unit comprising at least an LED load which may be turned on or turned off by a light sensing control unit. A motion sensing unit upon an intrusion detection activates the LED load to generate a high level illumination for a time length adjustable by a time setting unit. The LED load is operated in compliance with a power supply unit wherein a voltage V across each LED is confined in a range $V_{th}<V<V_{max}$, with V_{th} a threshold voltage and V_{max} a maximum voltage. The light-emitting unit may be configured with two LED lighting loads emitting lights with different color temperatures, wherein a power allocation circuitry may be installed to respectively distribute different electric powers to the two LED loads to manage a color temperature tuning scheme thru a light diffuser.

77 Claims, 16 Drawing Sheets



Related U.S. Application Data

continuation of application No. 15/637,175, filed on Jun. 29, 2017, now Pat. No. 10,165,643, which is a continuation of application No. 15/230,752, filed on Aug. 8, 2016, now Pat. No. 9,743,480, which is a continuation of application No. 14/478,150, filed on Sep. 5, 2014, now Pat. No. 9,445,474, which is a continuation of application No. 13/222,090, filed on Aug. 31, 2011, now Pat. No. 8,866,392.

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9,035,769	B2	5/2015	Steiner et al.	
9,271,345	B2	2/2016	Welten	
2005/0007025	A1	1/2005	Gauna	
2006/0022916	A1	2/2006	Aiello	
2007/0182338	A1	8/2007	Shteynberg et al.	
2007/0182347	A1	8/2007	Shteynberg et al.	
2008/0197783	A1	8/2008	Chen	
2008/0278934	A1	11/2008	Maldonado	
2008/0290822	A1 *	11/2008	Greene	H02J 17/00 315/363
2009/0189539	A1 *	7/2009	Deng	H05B 33/0812 315/294
2010/0141153	A1	6/2010	Recker et al.	
2011/0043133	A1	2/2011	Van Laanen et al.	
2012/0112677	A1	5/2012	Egger et al.	
2012/0206051	A1	8/2012	Nieuwlands	
2012/0262069	A1	10/2012	Reed	
2014/0062313	A1	3/2014	Ootsubo et al.	
2014/0210362	A1	7/2014	Shin et al.	
2015/0289339	A1	10/2015	Wu et al.	

* cited by examiner

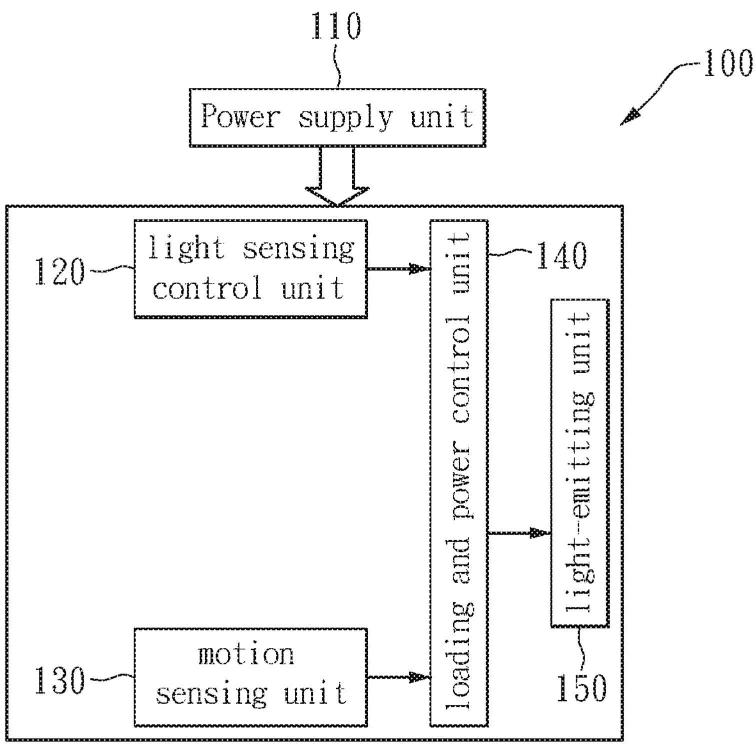

110
100
Power supply unit
120
light sensing control unit
140
loading and power control unit
light-emitting unit
130
motion sensing unit
150

FIG. 1

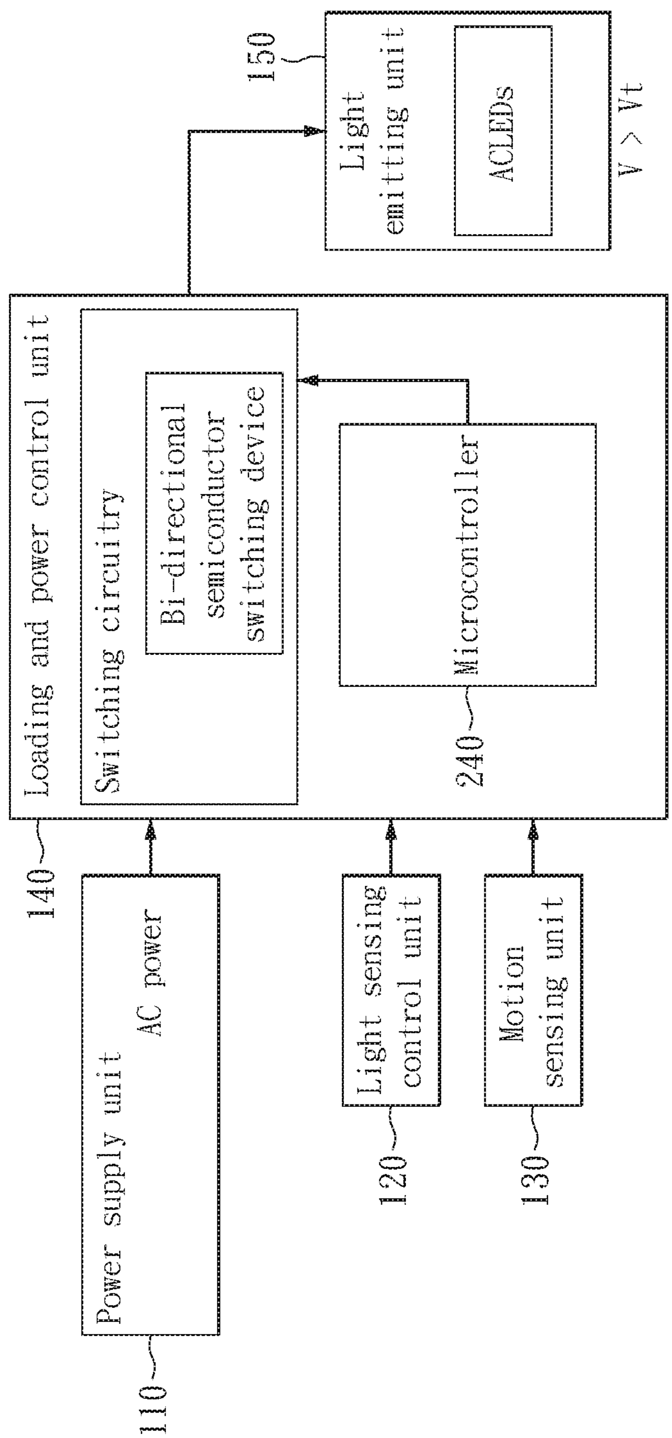

150
Light emitting unit
ACLEDs
V > Vt
Loading and power control unit
Switching circuitry
Bi-directional semiconductor switching device
Microcontroller
240
140
Power supply unit
AC power
Light sensing control unit
Motion sensing unit
110
120
130

FIG. 1A

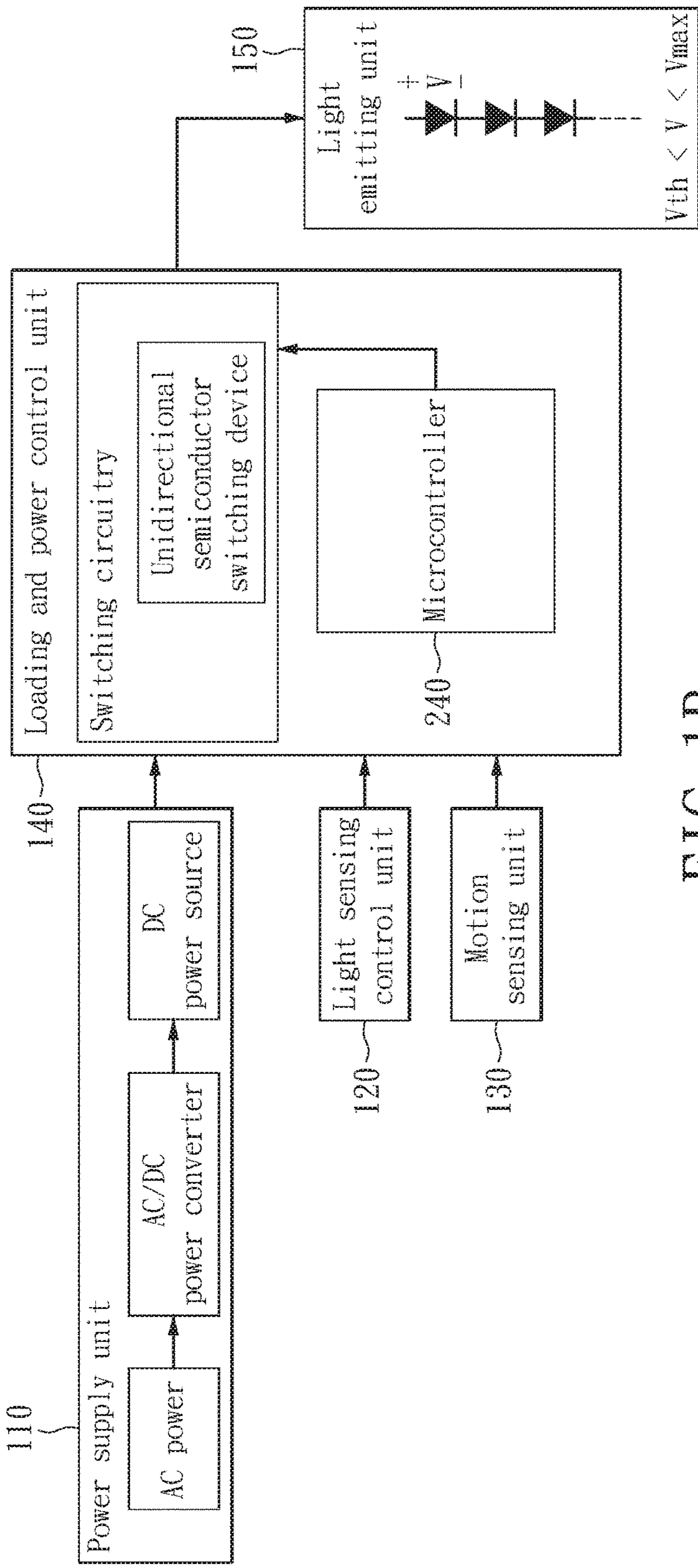

110
Power supply unit
AC power
AC/DC power converter
DC power source
140
Loading and power control unit
Switching circuitry
Unidirectional semiconductor switching device
Microcontroller
240
120
Light sensing control unit
130
Motion sensing unit
150
Light emitting unit
+ V −
Vth < V < Vmax

FIG. 1B

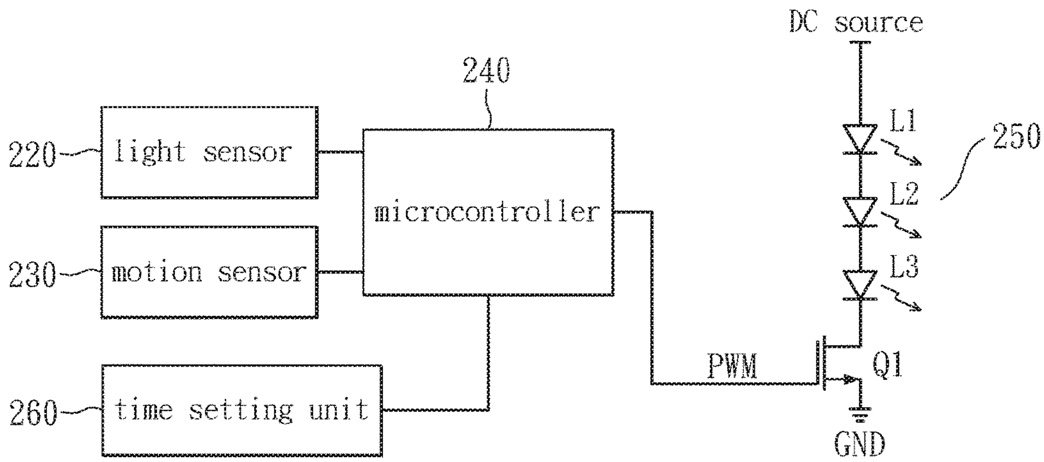

DC source
240
220
light sensor
microcontroller
L1
250
L2
230
motion sensor
L3
PWM
Q1
260
time setting unit
GND

FIG. 2A

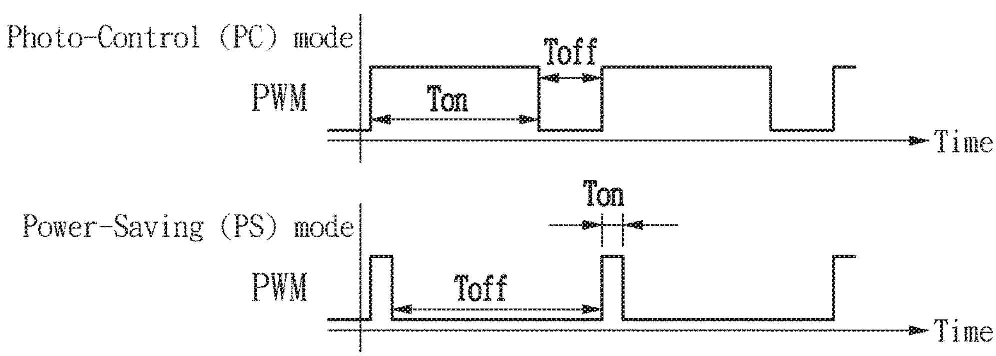
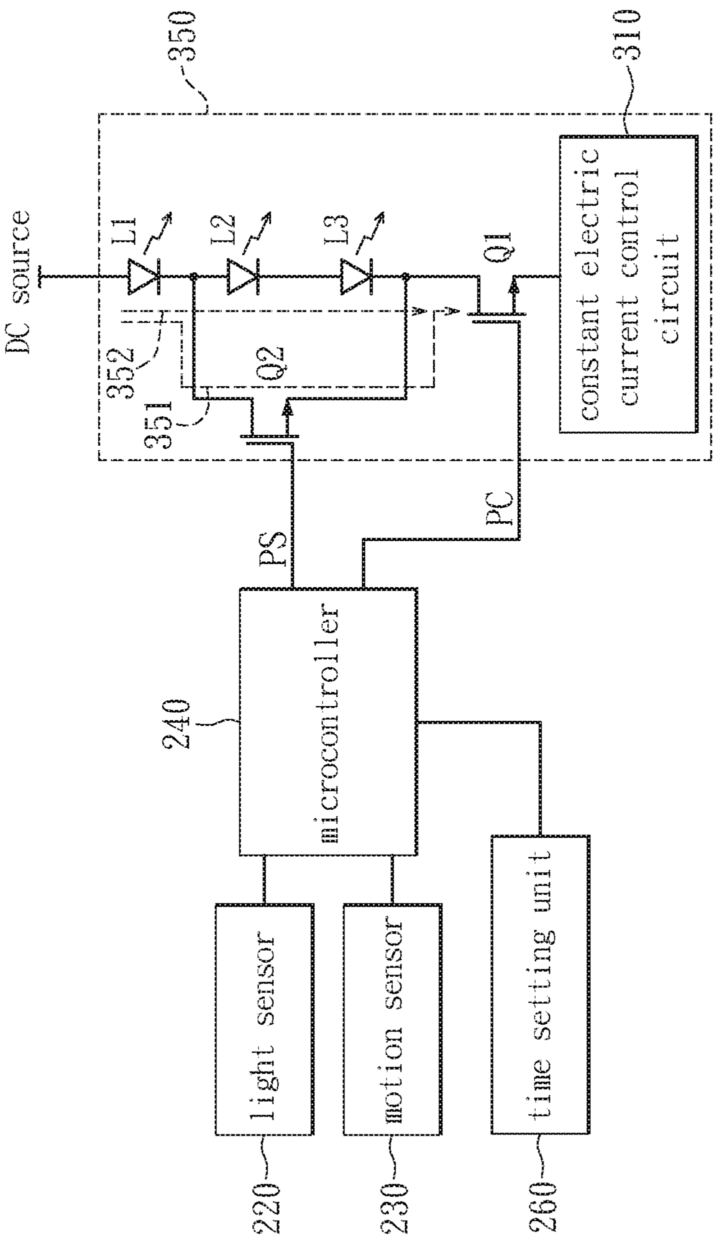


Photo-Control (PC) mode
Toff
PWM
Ton
Time
Ton
Power-Saving (PS) mode
PWM
Toff
Time

FIG. 2B



350
DC source
L1
L2
L3
Q1
Q2
352
351
310
constant electric current control circuit
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 3A

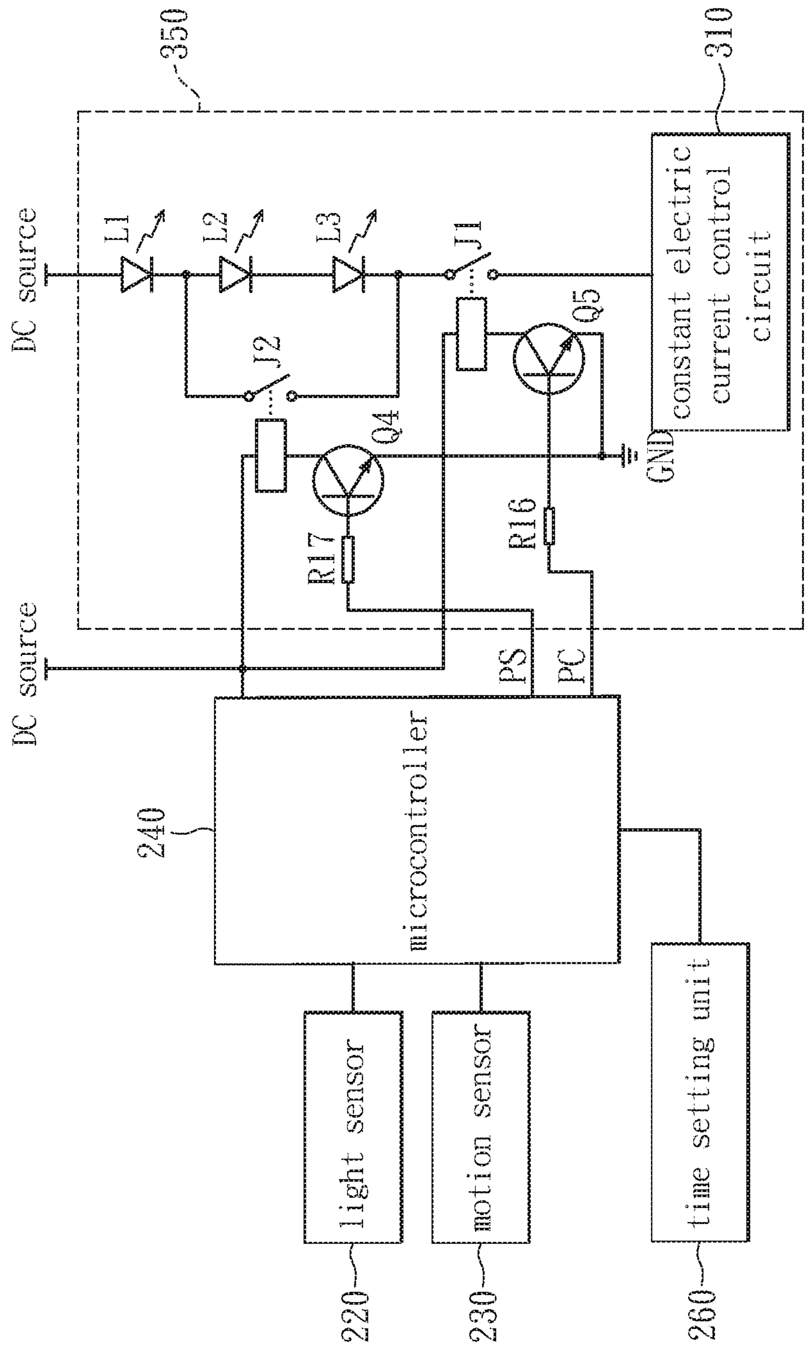

350
310
DC source
L1
L2
L3
J1
J2
Q4
Q5
R16
R17
GND
constant electric current control circuit
DC source
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 3B

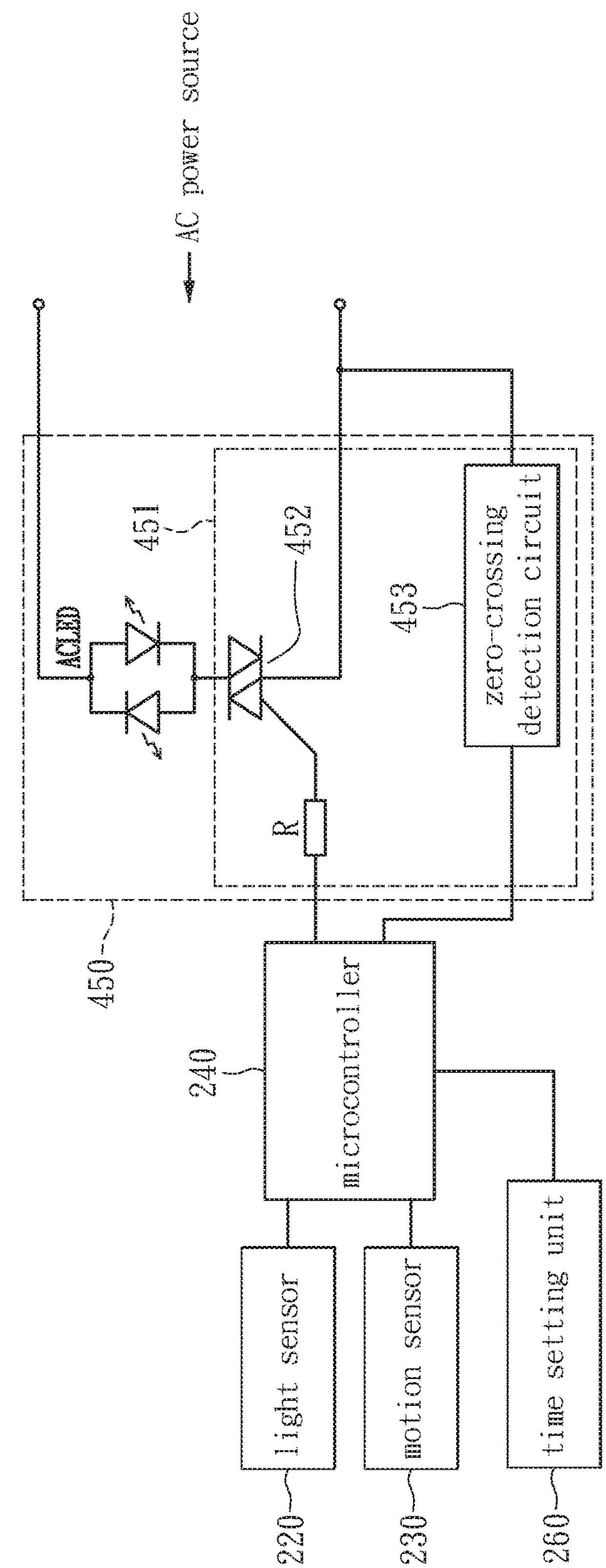

AC power source
ACLED
451
452
453
zero-crossing detection circuit
R
450
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 4A

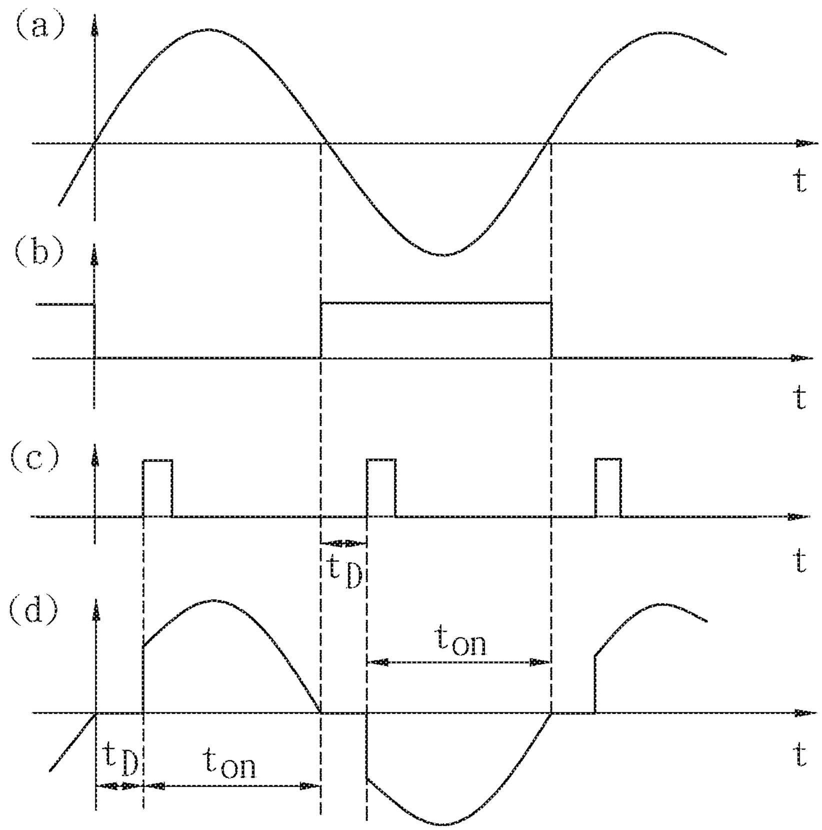


FIG. 4B

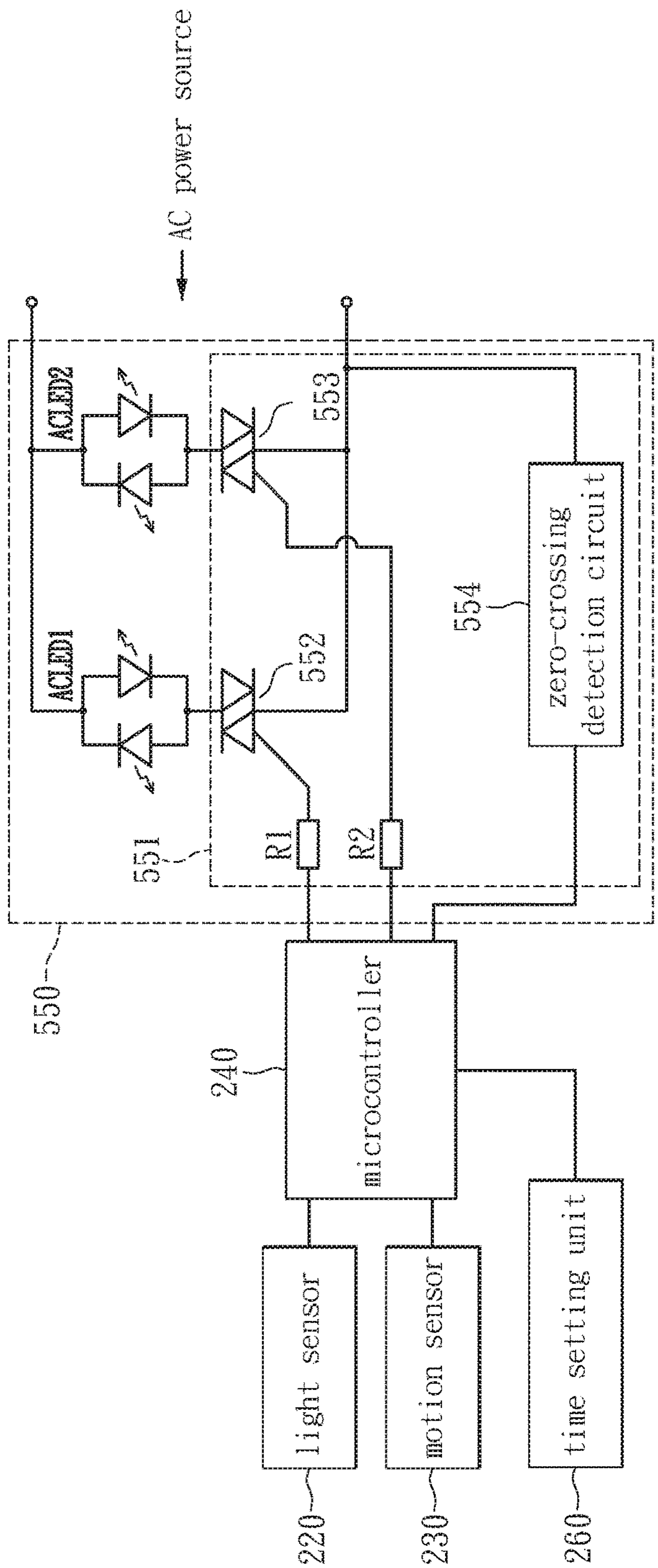

AC power source
ACLED1
ACLED2
550
551
552
553
554
R1
R2
zero-crossing detection circuit
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 5

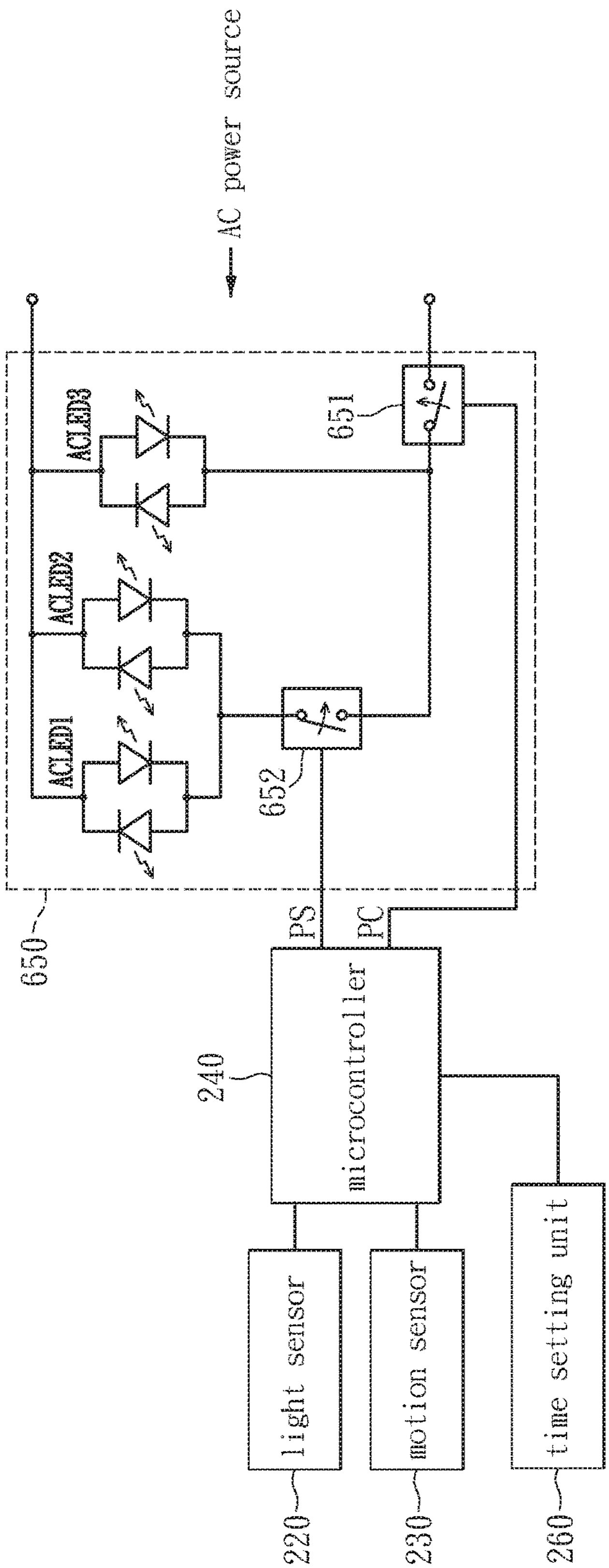

AC power source
ACLED1
ACLED2
ACLED3
651
652
650
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 6

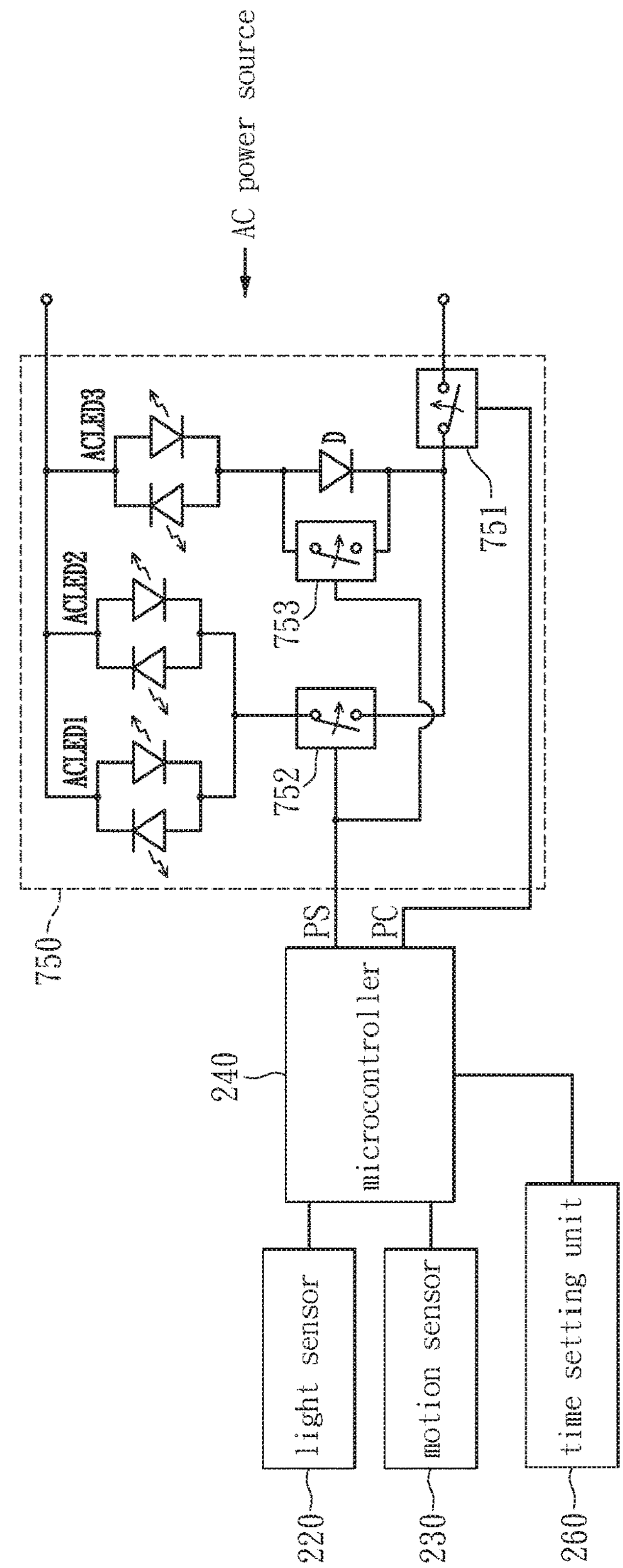

AC power source
ACLED1
ACLED2
ACLED3
D
751
752
753
750
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 7

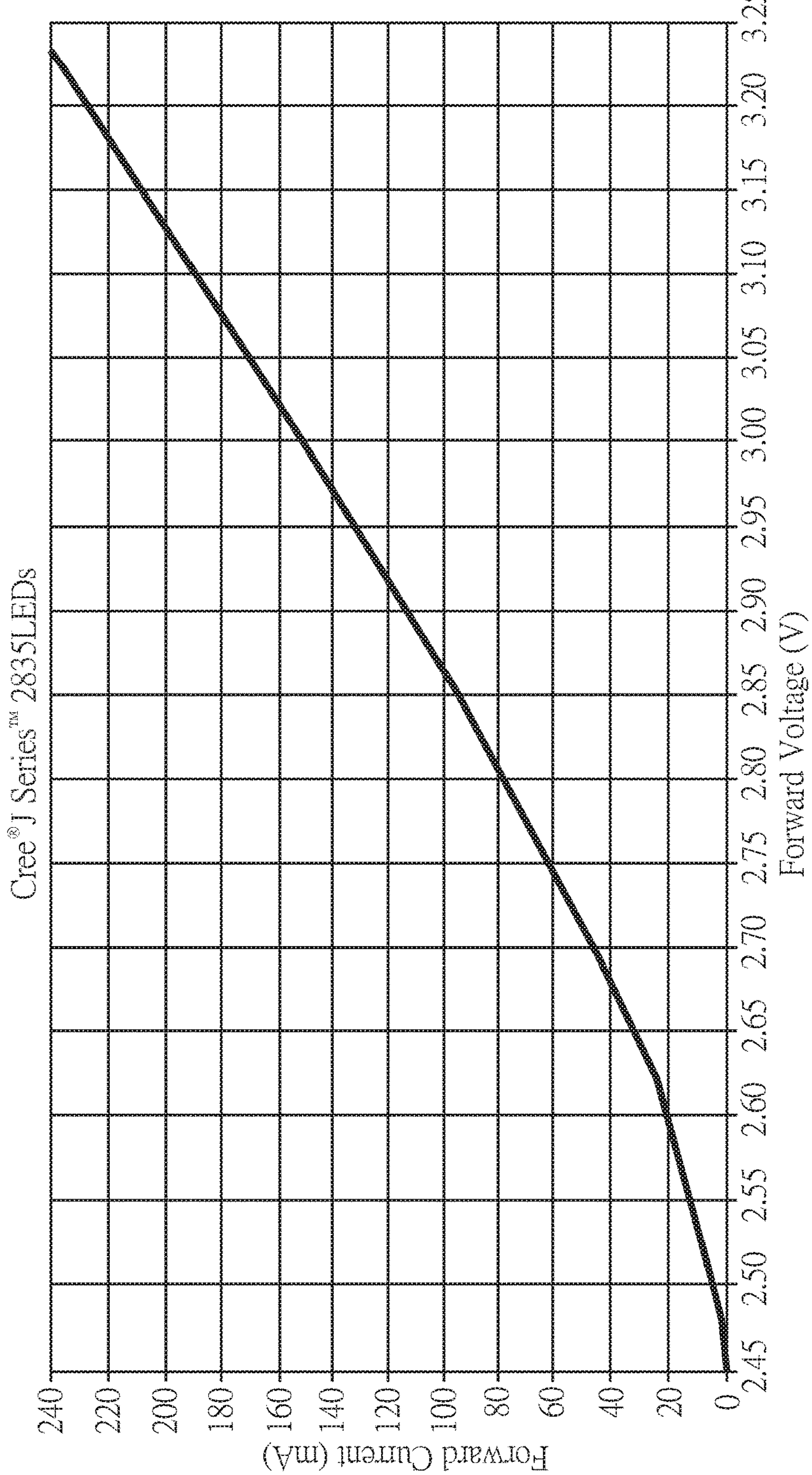

Cree® J Series™ 2835LEDs
Forward Current (mA)
240
220
200
180
160
140
120
100
80
60
40
20
0
2.45
2.50
2.55
2.60
2.65
2.70
2.75
2.80
2.85
2.90
2.95
3.00
3.05
3.10
3.15
3.20
3.25
Forward Voltage (V)

FIG. 8A

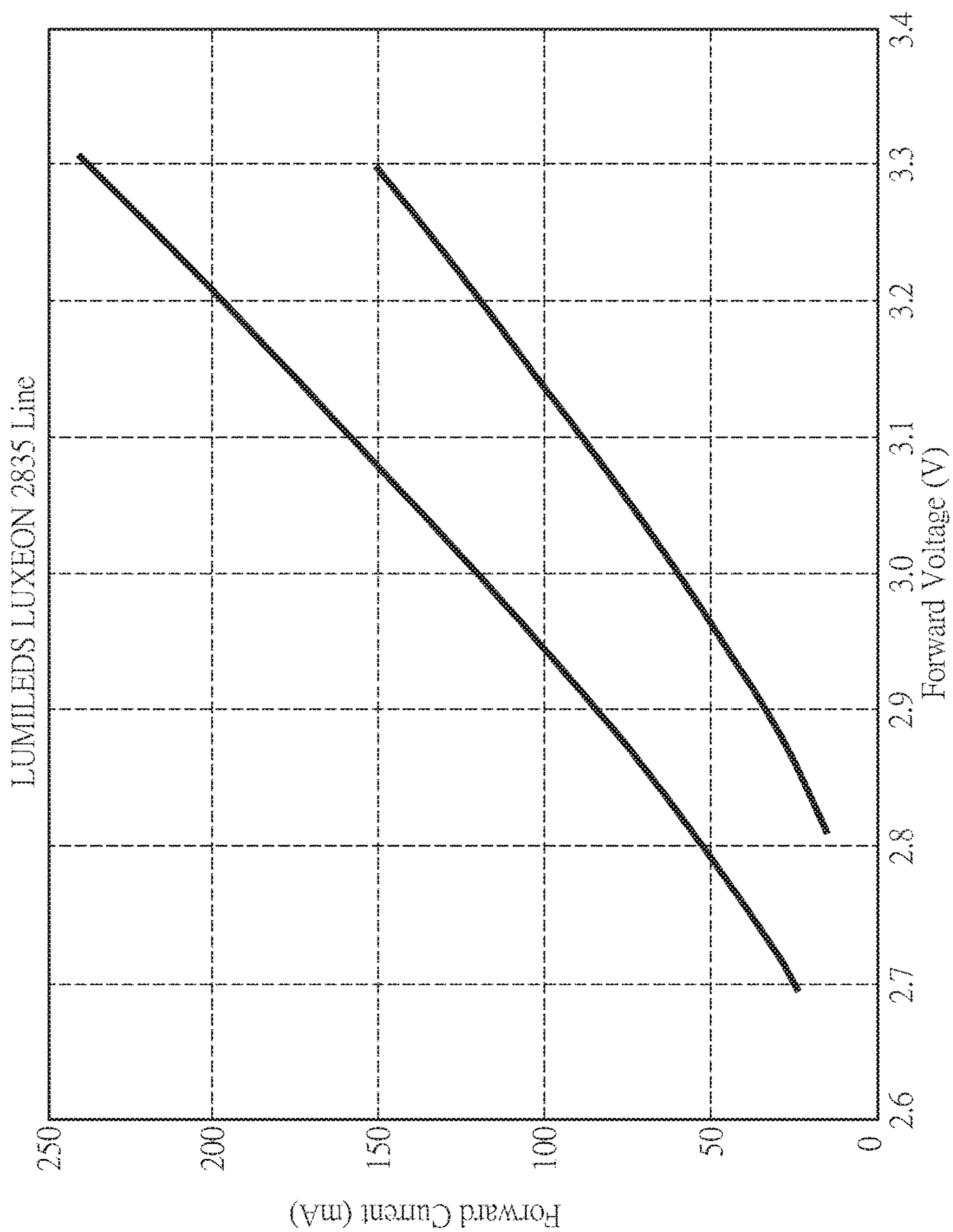
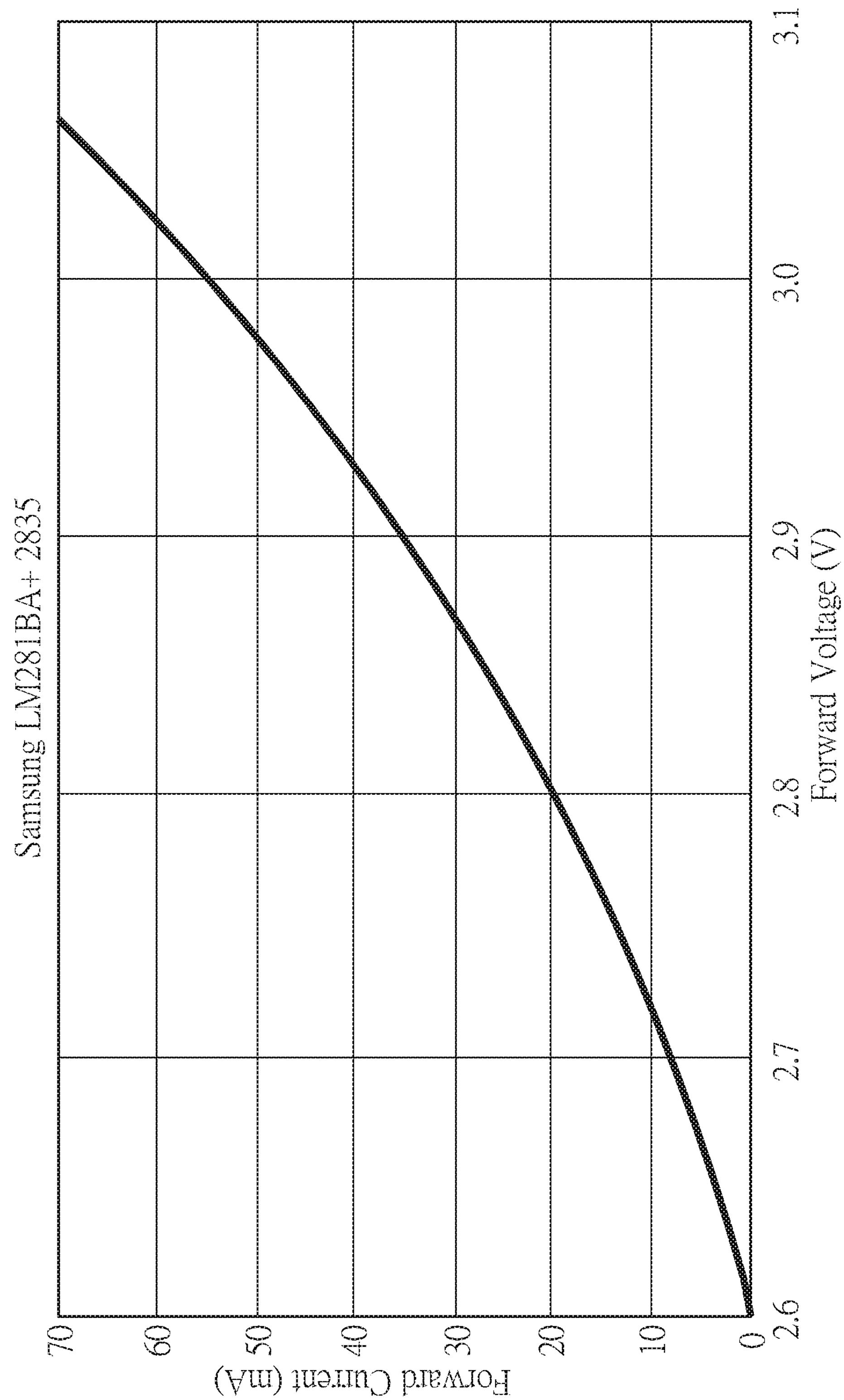

LUMILEDS LUXEON 2835 Line
Forward Current (mA)
250
200
150
100
50
0
Forward Voltage (V)
2.6
2.7
2.8
2.9
3.0
3.1
3.2
3.3
3.4

FIG. 8B



Samsung LM281BA+ 2835
Forward Current (mA)
70
60
50
40
30
20
10
0
Forward Voltage (V)
2.6
2.7
2.8
2.9
3.0
3.1

FIG. 8C

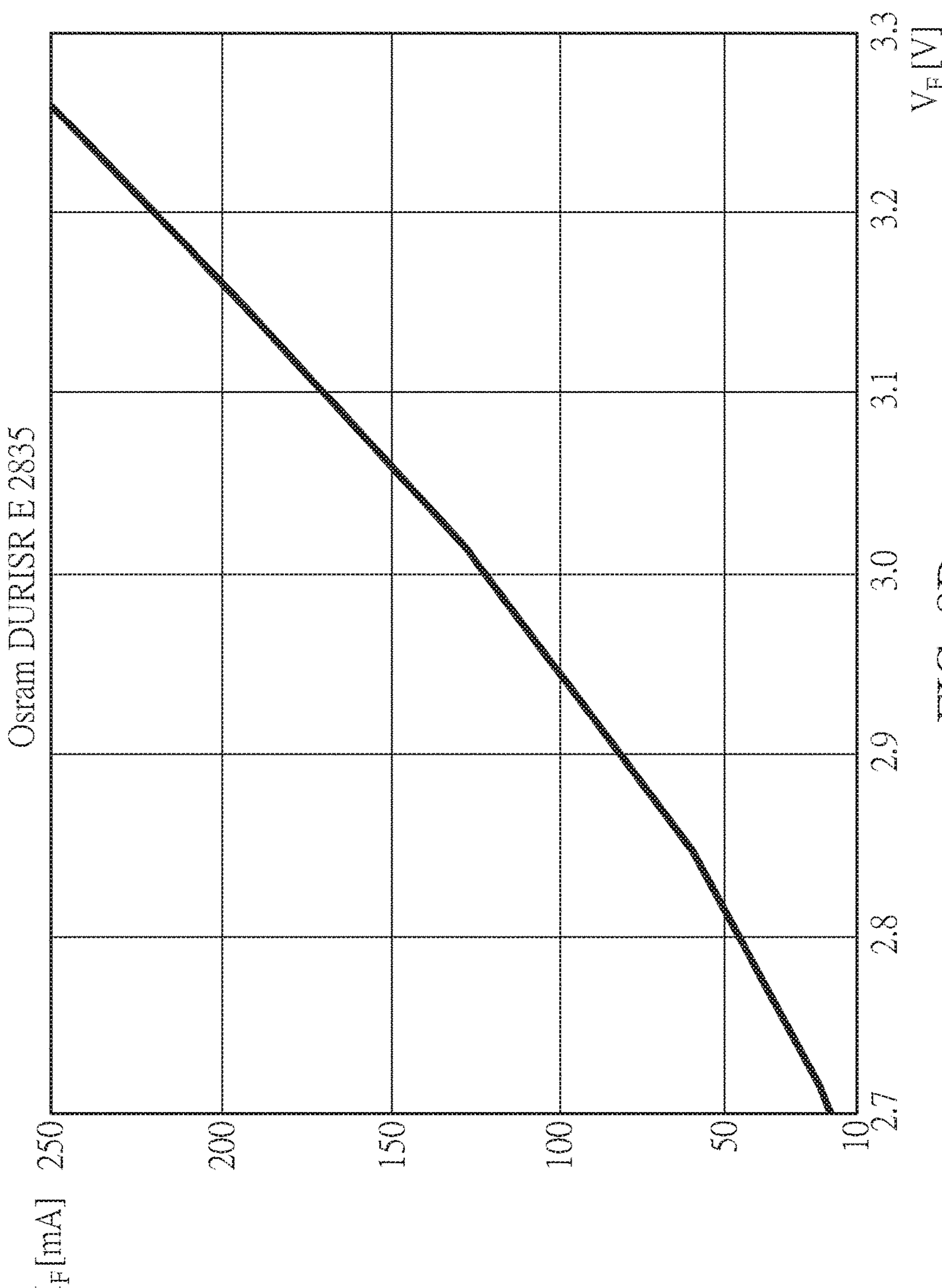

Osram DURISR E 2835
I_F [mA]
250
200
150
100
50
10
2.7
2.8
2.9
3.0
3.1
3.2
3.3
V_F [V]

FIG. 8D

Brand	V_F Min.	V_F Max.	Product Series	Information Source
CREE	2.9V	3.3V	J Series LEDs/J Series 2835	www.cree.com/led-components/products/j2835/jseries-2835
LUMILEDS	2.7V	3.3V	LUXEON 2835 Line	www.lumileds.com/luxeon2835line
SAMSUNG	2.9V	3.3V	KM281BA+	www.samsung.com/app/components/products/j2835/jseries-2835
OSRAM	2.7V	3.3V	DURIS® E/DURISR E 2835	www.osram.com/app/product_selector/#!?query=DORIS%20E%202835&sortField=&sortOrder=&start-0&filters=productbrand,DORIS,E&filters-productbrand,DORIS

FIG. 9

LIFESTYLE SECURITY LIGHT

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a continuation application of prior application Ser. No. 15/856,468 filed on Dec. 28, 2017, currently pending, which is a continuation application of prior application Ser. No. 15/637,175 filed on Jun. 29, 2017, currently pending, which is a continuation application of prior application Ser. No. 15/230,752 filed on Aug. 8, 2016, issued as U.S. Pat. No. 9,743,480 on Aug. 22, 2017, which is a continuation application of prior application Ser. No. 14/478,150 filed on Sep. 5, 2014, issued as U.S. Pat. No. 9,445,474 on Sep. 13, 2016, which is a continuation application of prior application Ser. No. 13/222,090 filed on Aug. 31, 2011, issued as U.S. Pat. No. 8,866,392 on Oct. 21, 2014.

BACKGROUND

1. Technical Field

The present disclosure relates to a lighting apparatus, in particular, to a two-level security LED light with motion sensor.

2. Description of Related Art

Lighting sources such as the fluorescent lamps, the incandescent lamps, the halogen lamps, and the light-emitting diodes (LED) are commonly found in lighting apparatuses for illumination purpose. Photo resistors are often utilized in outdoor lighting applications for automatic illuminations, known as the Photo-Control (PC) mode. Timers may be used in the PC mode for turning off the illumination or for switching to a lower level illumination of a lighting source after the lighting source having delivered a high level illumination for a predetermined duration, referred as the Power-Saving (PS) mode. Motion sensors are often used in the lighting apparatus for delivering full-power illumination thereof for a short duration when a human motion is detected, then switching back to the PS mode. Illumination operation controls such as auto-illumination in accordance to the background brightness detection, illumination using timer, illumination operation control using motion sensing results (e.g., dark or low luminous power to fully illuminated), and brightness control are often implemented by complex circuitries. In particular, the design and construction of LED drivers are still of a complex technology with high fabrication cost.

Therefore, how to develop a simple and effective design method on illumination controls such as enhancing contrast in illumination and color temperature for various types lighting sources, especially the controls for LEDs are the topics of the present disclosure.

SUMMARY

An exemplary embodiment of the present disclosure provides a two-level LED security light with motion sensor which may switch to high level illumination in the Power-Saving (PS) mode for a predetermined duration time when a human motion is detected thereby achieve warning purpose using method of electric current or lighting load adjustment. Furthermore, prior to the detection of an intrusion, the LED security light may be constantly in the low level illumination to save energy.

An exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit further includes one or a plurality of series-connected LEDs; when the light sensing control unit detects that an ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a high level or a low level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit increases the electric current that flows through the light-emitting unit so as to generate the high level illumination for a predetermined duration.

Another exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, a light-emitting unit. The light-emitting unit includes a plurality of series-connected LEDs. When the light sensing control unit detects that an ambient light is lower than a predetermined value, the loading and power control unit turns on a portion or all the LEDs of the light-emitting unit to generate a low level or a high level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off all the LEDs in the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit turns on a plurality of LEDs in the light-emitting unit and generates the high level illumination for a predetermine duration. An electric current control circuit is integrated in the exemplary embodiment for providing constant electric current to drive the LEDS in the light-emitting unit.

One exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes one or a plurality of parallel-connected alternating current (AC) LEDs. A phase controller is coupled between the described one or a plurality parallel-connected ACLEDs and AC power source. The loading and power control unit may through the phase controller control the average power of the light-emitting unit; when the light sensing control unit detects that an ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a high level or a lower level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit increases the average power of the light-emitting unit thereby generates the high level illumination for a predetermine duration.

According to an exemplary embodiment of the present disclosure, a two-level LED security light includes a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes X high wattage ACLEDs and Y low wattage ACLEDs connected in parallel. When the light sensing control unit detects that an ambient light is lower than a predetermined value, the loading and power control unit turns on the plurality of low wattage

ACLEDs to generate a low level illumination; when the light sensing control unit detects that the ambient light is higher than a predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensor detects an intrusion, the loading and power control unit turns on both the high wattage ACLEDs and the low wattage ACLEDs at same time thereby generates a high level illumination for a predetermine duration, wherein X and Y are of positive integers.

According to an exemplary embodiment of the present disclosure, a two-level LED security light with motion sensor includes a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes a rectifier circuit connected between one or a plurality of parallel-connected AC lighting sources and AC power source. The loading and power control unit may through the rectifier circuit adjust the average power of the light-emitting unit. When the light sensing control unit detects that an ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a low level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects an intrusion, the loading and power control unit increases the average power of the light-emitting unit thereby generates a high level illumination for a predetermine duration. The rectifier circuit includes a switch parallel-connected with a diode, wherein the switch is controlled by the loading and power control unit.

To sum up, a two-level LED security light with motion sensor provided by an exemplary embodiment in the preset disclosure, may execute Photo-Control (PC) and Power-Saving (PS) modes. When operates in the PC mode, the lighting apparatus may auto-illuminate at night and auto turn off at dawn. The PC mode may generate a high level illumination for a predetermined duration then automatically switch to the PS mode by a control unit to generate a low level illumination. When the motion sensor detects a human motion, the disclosed LED security light may immediately switch to the high level illumination for a short predetermined duration thereby achieve illumination or warning effect. After the short predetermined duration, the LED security light may automatically return to the low level illumination for saving energy. The PC mode may alternatively generate the low level illumination to begin with and when the motion sensor is detected the disclosed LED security may immediately switch to a high level illumination for a short predetermined duration to provide security protection and then automatically return to the low level illumination.

In order to further understand the techniques, means and effects of the present disclosure, the following detailed descriptions and appended drawings are hereby referred, such that, through which, the purposes, features and aspects of the present disclosure can be thoroughly and concretely appreciated; however, the appended drawings are merely provided for reference and illustration, without any intention to be used for limiting the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the present disclosure, and are incorporated in and constitute a part of this specification. The drawings illustrate exemplary embodiments of the present disclosure and, together with the description, serve to explain the principles of the present disclosure.

FIG. **1** schematically illustrates a block diagram of a two-level LED security light in accordance with an exemplary embodiment of the present disclosure.

FIG. **1**A is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for an ACLED two-level security light, wherein the loading and power comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises a bidirectional semiconductor switching device for controlling an average electric power to be delivered to the ACLED.

FIG. **1**B is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for a DC LED two level security light, wherein the loading and power control unit comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises an unidirectional semiconductor switching device for controlling an average electric power to be delivered to the DC LED.

FIG. **2**A illustrates a schematic diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure.

FIG. **2**B graphically illustrates a timing waveform of a pulse width modulation (PWM) signal in accordance to the first exemplary embodiment of the present disclosure.

FIG. **3**A illustrates a schematic diagram of a two-level LED security light in accordance to the second exemplary embodiment of the present disclosure.

FIG. **3**B illustrates a schematic diagram of a two-level LED security light in accordance to the second exemplary embodiment of the present disclosure.

FIG. **4**A illustrates a schematic diagram of a two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **4**B illustrates a timing waveform of two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **5** illustrates a schematic diagram of a two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **6** illustrates a schematic diagram of a two-level LED security light in accordance to the fourth exemplary embodiment of the present disclosure.

FIG. **7** illustrates a schematic diagram of a two-level LED security light in accordance to the fifth exemplary embodiment of the present disclosure.

FIGS. **8**A, **8**B, **8**C and **8**D schematically and respectively show V-I relationship charts (Forward Current vs. Forward Voltage) for a white LED chip from each of 4 different LED manufacturers.

FIG. **9** is a data sheet showing data of the minimum forward voltages and maximum forward voltages collected from various LED manufacturers.

DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

Reference is made in detail to the exemplary embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or alike parts.

First Exemplary Embodiment

Refer to FIG. **1**, which schematically illustrates a block diagram of a two-level LED security light in accordance to

the first exemplary embodiment of the present disclosure. A two-level LED security light (herein as the lighting apparatus) **100** includes a power supply unit **110**, a light sensing control unit **120**, a motion sensing unit **130**, a loading and power control unit **140**, and a light-emitting unit **150**. The power supply unit **110** is used for supplying power required to operate the system, wherein the associated structure includes the known AC/DC voltage converter. The light sensing control unit **120** may be a photoresistor, which may be coupled to the loading and power control unit **140** for determining daytime or nighttime in accordance to the ambient light. The motion sensing unit **130** may be a passive infrared sensor (PIR), which is coupled to the loading and power control unit **140** and is used to detect intrusions. When a person is entering a predetermined detection zone of the motion sensing unit **130**, a sensing signal thereof may be transmitted to the loading and power control unit **140**.

The loading and power control unit **140** which is coupled to the light-emitting unit **150** may be implemented by a microcontroller electrically coupled with a switching circuitry electrically connected between the light-emitting unit **150** and the power supply unit **110**. The switching circuitry may comprise a plurality of semiconductor switching components. The loading and power control unit **140** may control the illumination levels of the light-emitting unit **150** in accordance to the sensing signal outputted by the light sensing control unit **120** and the motion sensing unit **130**. The light-emitting unit **150** may include a plurality of LEDs. The loading and power control unit **140** may control the light-emitting unit **150** to generate at least two levels of illumination variations.

When the light sensing control unit **120** detects that an ambient light is lower than a predetermined value (i.e., nighttime), the loading and power control unit **140** executes the Photo-Control (PC) mode by turning on the light-emitting unit **150** to generate a high level illumination for a predetermined duration then return to a low level illumination for Power-Saving (PS) mode or it may alternatively generate the low level illumination to perform the power saving mode. When the light sensing control unit **120** detects that the ambient light is higher than a predetermined value (i.e., dawn), the loading and power control unit **140** turns off the light-emitting unit **150**. In the PS mode, when the motion sensing unit **130** detects a human motion, the loading and power control unit **140** may increase the electric current which flows through the light-emitting unit **150**, to generate another high level illumination for a short predetermined duration. After the short predetermined duration, the loading and power control unit **140** may automatically lower the electric current that flow through the light-emitting unit **150** thus have the light-emitting unit **150** return to low level illumination for saving energy.

Refer to **2**A, which illustrates a schematic diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure. The light sensing control unit **120** may be implemented by a light sensor **220**; the motion sensing unit **130** may be implemented by a motion sensor **230**; the loading and power control unit **140** may be implemented by a microcontroller **240** electrically coupled to a switching circuitry **Q1**. The light-emitting unit **250** includes three series-connected LEDs L**1**~L**3**. The LEDs L**1**~L**3** is connected between a DC source and a transistor Q**1**, wherein the DC source may be provided by the power supply unit **110**. The transistor Q**1** may be an N-channel metal-oxide-semiconductor field-effect-transistor (NMOS). The transistor Q**1** is connected between the three series-connected LEDs L**1**~L**3** and a ground GND. The loading and power control unit **140** implemented by the microcontroller **240** may output a control signal like a pulse width modulation (PWM) signal to control an average electric current delivered to the light-emitting unit **250**. It is worth to note that the electric components depicted in FIG. **2**A only serves as an illustration for the exemplary embodiment of the present disclose and hence the present disclosure is not limited thereto.

Refer to FIG. **2**B concurrently, which graphically illustrates a timing waveform of a pulse width modulation (PWM) signal in accordance to the first exemplary embodiment of the present disclosure. In the PC mode, the PWM signal may be used to configure the transistor Q**1** to have the conduction period T_{on} being longer than the cut-off period T_{off}. On the other hand in the PS mode, the PWM signal may configure the transistor Q**1** to have the conduction period T_{on} being shorter than the cut-off period T_{off}. In comparison of the illumination levels between the PC and PS modes, as the conduction period T_{on} of transistor Q**1** being longer under the PC mode, therefore have higher average electric current driving the light-emitting unit **250** thereby generate high illumination, which may be classified as the high level illumination; whereas as the conduction period T_{on} of transistor Q**1** is shorter in the PS mode, therefore have lower average electric current driving the light-emitting unit **250** thereby generate low illumination, which may be classified as the low level illumination.

The microcontroller **240** turns off the light-emitting unit **250** during the day and activates the PC mode at night by turning on the light-emitting unit **250** to generate the high level illumination for a short predetermined duration then return to the low level illumination thereby entering the PS mode. When the motion sensor **230** detects a human motion in the PS mode, the light-emitting unit **250** may switch to the high level illumination for illumination or warning application. The light-emitting unit **250** may return to the low level illumination after maintaining at the high level illumination for a short predetermined duration to save energy.

In addition, the microcontroller **240** is coupled to a time setting unit **260**, wherein the time setting unit **260** may allow a user to configure the predetermined duration associated with the high level illumination in the PC mode, however the present disclosure is not limited thereto. The time setting unit **260** may also be used for setting a predetermined time duration associated with the low level illumination as well as a predetermined time duration associated with a motion activated high level illumination. The time setting unit **260** is typically configured with an analogue circuitry comprising a resister and a capacitor for setting a time length. However, if precision of time length is crucial or much preferred, a digital circuitry may be employed, wherein a voltage divider with a variable resister coupled to the microcontroller designed with a time setting subroutine or a push button device coupled with a grounding pin of the microcontroller designed with the time setting subroutine for more precisely setting a time length for performing an illumination mode.

Second Exemplary Embodiment

Refer again to FIG. **1**, wherein the illumination variations of the light-emitting unit **150** may be implemented through the number of light-source loads being turned on to generate more than two levels of illumination. The lighting apparatus **100** in the instant exemplary embodiment may be through turning on a portion of LEDs or all the LEDs to generate a low and a high level of illuminations.

Refer to FIG. 3A concurrently, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the second exemplary embodiment of the present disclosure. The main difference between FIG. **3**A and FIG. **2**A is in the light-emitting unit **350**, having three series-connected LEDs L**1**~L**3** and NMOS transistors Q**1** and Q**2**. The LEDs L**1**~L**3** are series connected to the transistor Q**1** at same time connected between the DC source and a constant electric current control circuit **310**. Moreover, transistor Q**2** is parallel connected to the two ends associated with LEDs L**2** and L**3**. The gates of the transistors Q**1** and Q**2** are connected respectively to a pin PC and a pin PS of the microcontroller **240**. The constant electric current control circuit **310** in the instant exemplary embodiment maintains the electric current in the activated LED at a constant value, namely, the LEDs L**1**~L**3** are operated in constant-current mode.

Refer to FIG. **3**A, the pin PC of the microcontroller **240** controls the switching operations of the transistor Q**1**; when the voltage level of pin PC being either a high voltage or a low voltage, the transistor Q**1** may conduct or cut-off, respectively, to turn the LEDs L**1**~L**3** on or off. The pin PS of the microcontroller **240** controls the switch operations of the transistor Q**2**, to form two current paths **351** and **352** on the light-emitting unit **350**. When the voltage at the pin PS of the microcontroller **240** is high, the transistor Q**2** conducts, thereby forming the current path **351** passing through the LED L**1** and the transistor Q**2**; when the voltage at the pin PS being low, the transistor Q**2** cuts-off, thereby forming the current path **352** passing through all the LEDs L**1**~L**3**. The microcontroller **240** may then control the switching operation of the transistor Q**2** to turn on the desired number of LEDs so as to generate a high or a low level illumination.

When light sensor **220** determines that an ambient light is higher than a predetermined value, the microcontroller **240** through the pin PC outputs a low voltage, which causes the transistor Q**1** to cut-off and turns off all the LEDs L**1**~L**3** in the light-emitting unit **350**. Conversely, when the light sensor **220** detects that the ambient light is lower than the predetermined value, the microcontroller **240** activates the PC mode, i.e., outputting a high voltage from pin PC and a low voltage from pin PS, to activate the transistor Q**1** while cut-off the transistor Q**2**, thereby forming the current path **352**, to turn on the three LEDs L**1**~L**3** in the light-emitting unit **350** so as to generate the high level illumination for a predetermined duration. After the predetermined duration, the microcontroller **240** may switch to the PS mode by having the pin PC continue outputting a high voltage and the pin PS outputting a high voltage, to have the transistor Q**2** conducts, thereby forming the current path **351**. Consequently, only the LED L**1** is turned on and the low level illumination is generated.

When the motion sensor detects a human motion in the PS mode, the pin PS of the microcontroller **240** temporarily switches from the high voltage to a low voltage, to have the transistor Q**2** temporarily cuts-off thus forming the current path **352** to activate all the LEDs in the light-emitting unit **350**, thereby temporarily generates the high level illumination. The light-emitting unit **350** is driven by a constant electric current, therefore the illumination level generated thereof is directly proportional to the number of LEDs activated. FIG. **3**B illustrates another implementation for FIG. **3**A, wherein the relays J**1** and J**2** are used in place of NMOS transistors to serve as switches. The microcontroller **240** may control the relays J**2** and J**1** through regulating the switching operations of the NPN bipolar junction transistors Q**4** and Q**5**. Moreover, resistors R**16** and R**17** are current-limiting resistors.

In the PC mode, the relay J**1** being pull-in while the relay J**2** bounce off to have constant electric current driving all the LEDs L**1**~L**3** to generate the high level illumination; in PS mode, the relays J**1** and J**2** both pull-in to have constant electric current only driving the LED L**1** thus the low level illumination may be thereby generated. Furthermore, when the motion sensor **230** detects a human motion, the pin PS of the microcontroller **240** may temporarily switch from high voltage to low voltage, forcing the relay J**2** to temporarily bounce off and the relay J**1** pull-in so as to temporarily generate the high level illumination.

The LED L**1** may adopt a LED having color temperature of 2700K while the LEDs L**2** and L**3** may adopt LEDs having color temperature of 5000K in order to increase the contrast between the high level and the low level illuminations. The number of LEDs included in the light-emitting unit **350** may be more than three, for example five or six LEDs. The transistor Q**2** may be relatively parallel to the two ends associated with a plurality of LEDs to adjust the illumination difference between the high and the low illumination levels. Additionally, the light-emitting unit **350** may be connected to a plurality of transistors Q**2**, which are respectively coupled to the two ends associated with each LED to provide more lighting variation selections. The microcontroller **240** may decide the number of LEDs to turn on in accordance to design needs at different conditions. Based on the explanation of the aforementioned exemplary embodiment, those skills in the art should be able to deduce other implementation and further descriptions are therefore omitted.

Third Exemplary Embodiment

Refer back to FIG. **1**, wherein the light-emitting unit **150** may include one or more parallel-connected alternating current (AC) LEDs. A phase controller is coupled between the described one or more parallel-connected ACLEDs and AC power source. The loading and power controller **140** in the instant exemplary embodiment may through the phase controller adjust the average power of the light-emitting unit **150** so as to generate variations in the low level and the high level illuminations.

Refer to FIG. **4**A, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the third exemplary embodiment of the present disclosure. The main difference between FIG. **4**A and FIG. **3** is in that the light-source load is an ACLED, which is coupled to the AC power source, and further the light-emitting unit **450** is connected to a phase controller **451**. The phase controller **451** includes a bi-directional switching device **452**, here, a triac, a zero-crossing detection circuit **453**, and a resistor R. The microcontroller **240** turns off the light-emitting unit **450** when the light sensor **220** detects that the ambient light is higher than a predetermined value. Conversely, when the light sensor **220** detects that the ambient light is lower than the predetermined value, the microcontroller **240** activates the PC mode by turning on the light-emitting unit **450**. In the PC mode, the microcontroller **240** may select a control pin for outputting a pulse signal which through a resistor R triggers the triac **452** to have a large conduction angle. The large conduction angle configures the light-emitting unit **450** to generate a high level illumination for a predetermined duration. Then the microcontroller **240** outputs the pulse signal for PS mode through the same control pin to trigger

the triac **452** to have a small conduction angle for switching the light-emitting unit **450** from the high level illumination to the low level illumination of the PS mode. Moreover, when the motion sensor **230** (also called motion sensing unit) detects a human motion in the PS mode, the microcontroller **240** temporarily outputs the PC-mode pulse signal through the same control pin to have the light-emitting unit **450** generated the high level illumination for a short predetermined duration. After the short predetermined duration, the light-emitting unit **450** returns to the low level illumination.

In the illumination control of the ACLED, the microcontroller **240** may utilize the detected zero-crossing time (e.g., the zero-crossing time of an AC voltage waveform) outputted from the zero-crossing detection circuit **453** to send an AC synchronized pulse signal thereof which may trigger the triac **452** of the phase controller **451** thereby to change the average power input to the light-emitting unit **450**. As the ACLED has a cut-in voltage V_t for start conducting, thus if the pulse signal inaccurately in time triggers the conduction of the triac **452**, then the instantaneous value of AC voltage may be lower than the cut-in voltage V_t of ACLED at the trigger pulse. Consequently, the ACLED may result in the phenomenon of either flashing or not turning on. Therefore, the pulse signal generated by the microcontroller **240** must fall in a proper time gap behind the zero-crossing point associated with the AC sinusoidal voltage waveform.

Supposing an AC power source having a voltage amplitude V_m and frequency f, then the zero-crossing time gap t_D of the trigger pulse outputted by the microcontroller **240** should be limited according to $t_o<t_D<1/2\ f-t_o$ for a light-source load with a cut-in voltage V_t, wherein $t_o=(1/2\pi f)\sin^{-1}(V_t/V_m)$. The described criterion is applicable to all types of ACLEDs to assure that the triac **452** can be stably triggered in both positive and negative half cycle of the AC power source. Take ACLED with V_t(rms)=80V as an example, and supposing the V_m(rms)=110V and f=60 Hz, then t_o=2.2 ms and (1/2f)=8.3 ms may be obtained. Consequently, the proper zero-crossing time gap t_D associated with the phase modulation pulse outputted by the microcontroller **240** which lagged the AC sinusoidal voltage waveform should be designed in the range of 2.2 ms<t_D<6.1 ms.

Refer to FIG. **4**B, which illustrates a timing waveform of the two-level LED security light in accordance to the third exemplary embodiment of the present disclosure. Waveforms (a)~(d) of FIG. **4**B respectively represent the AC power source, the output of the zero-crossing detection circuit **453**, the zero-crossing delay pulse at the control pin of the microcontroller **240**, and the voltage waveform across the two ends of the ACLED in the light-emitting unit **450**. The zero-crossing detection circuit **453** converts the AC voltage sinusoidal waveform associated with the AC power source to a symmetric square waveform having a low and a high voltage levels as shown in FIG. **4**B(b). At the zero-crossing point of the AC voltage sinusoidal wave, the symmetric square waveform may transit either from the low voltage level to the high voltage level or from the high voltage level to the low voltage level. Or equivalently, the edge of the symmetric square waveform in the time domain corresponds to the zero-crossing point of the AC voltage sinusoidal waveform. As shown in FIG. **4**B(c), the microcontroller **240** outputs a zero-crossing delay pulse in correspondence to the zero-crossing point of the AC sinusoidal waveform in accordance to the output waveform of the zero-crossing detection circuit **453**. The zero-crossing delay pulse is relative to an edge of symmetric square waveform behind a time gap t_D in the time domain. The t_D should fall in a valid range, as described previously, to assure that the triac **452** can be stably triggered thereby to turn on the ACLED. FIG. **4**B(d) illustrates a voltage waveform applied across the two ends associated with the ACLED. The illumination level of the light-emitting unit **450** is related to the conduction period t_{on} of the ACLED, or equivalently, the length t_{on} is directly proportional to the average power inputted to the ACLED. The difference between the PC mode and the PS mode being that in the PC mode, the ACLED has longer conduction period, thereby generates the high level illumination; whereas in the PS mode, the ACLED conduction period is shorter, hence generates the low level illumination.

Refer to FIG. **5**, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the third exemplary embodiment of the present disclosure. The light-emitting unit **550** of the lighting apparatus **100** includes an ACLED**1**, an ACLED**2**. The phase controller **551** includes triacs **552** and **553**, the zero-crossing detection circuit **554** as well as resistors R**1** and R**2**. The light-emitting unit **550** of FIG. **5** is different from the light-emitting unit **450** of FIG. **4** in that the light-emitting unit **550** has more than one ACLED and more than one bi-directional switching device. Furthermore, the color temperatures of the ACLED**1** and the ACLED**2** may be selected to be different.

In the exemplary embodiment of FIG. **5**, the ACLED**1** has a high color temperature, and the ACLED**2** has a low color temperature. In the PC mode, the microcontroller **240** uses the phase controller **551** to trigger both ACLED**1** and ACLED**2** to conduct for a long period, thereby to generate the high level illumination as well as illumination of mix color temperature. In the PS mode, the microcontroller **240** uses the phase controller **551** to trigger only the ACLED**2** to conduct for a short period, thereby generates the low level illumination as well as illumination of low color temperature. Moreover, in the PS mode, when the motion sensor **230** detects a human motion, the microcontroller **240** may through the phase controller **551** trigger the ACLED**1** and ACLED**2** to conduct for a long period. Thereby, it may render the light-emitting unit **450** to generate the high level illumination of high color temperature and to produce high contrast in illumination and hue, for a short predetermined duration to warn the intruder. Consequently, the lighting apparatus may generate the high level or the low level illumination of different hue. The rest of operation theories associated with the light-emitting unit **550** are essentially the same as the light-emitting unit **450** and further descriptions are therefore omitted.

Fourth Exemplary Embodiment

Refer to FIG. **6**, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the fourth exemplary embodiment of the present disclosure. The light-emitting unit **150** of FIG. **1** may be implemented by the light-emitting unit **650**, wherein the light-emitting unit **650** includes three ACLED**1**~**3** having identical luminous power electrically connected to switches **651** and **652**. In which, switches **651** and **652** may be relays. The parallel-connected ACLED**1** and ACLED**2** are series-connected to the switch **652** to produce double luminous power, and of which the ACLED**3** is parallel connected to, to generate triple luminous power, and of which an AC power source is further coupled to through the switch **651**. Moreover, the microcontroller **240** implements the loading and power control unit **140** of FIG. **1**. The pin PC and pin PS are respectively

connected to switches **651** and **652** for outputting voltage signals to control the operations of switches **651** and **652** (i.e., open or close).

In the PC mode, the pin PC and pin PS of the microcontroller **240** control the switches **651** and **652** to be closed at same time. Consequently, the ACLED**1~3** are coupled to the AC power source and the light-emitting unit **650** may generate a high level illumination of triple luminous power. After a short predetermined duration, the microcontroller **240** returns to PS mode. In which the switch **651** is closed while the pin PS controls the switch **652** to be opened, consequently, only the ACLED**3** is connected to AC power source, and the light-emitting unit **650** may thus generate the low level illumination of one luminous power. In the PS mode, when the motion sensor **230** detects a human motion, the microcontroller **240** temporarily closes the switch **652** to generate high level illumination with triple luminous power for a predetermined duration. After the predetermined duration, the switch **652** returns to open status thereby to generate the low level illumination of one luminous power. The lighting apparatus of FIG. **6** may therefore through controlling switches **651** and **652** generate two level illuminations with illumination contrast of at least 3 to 1.

The ACLED**1** and ACLED**2** of FIG. **6** may be high power lighting sources having color temperature of 5000K. The ACLED**3** may be a low power lighting source having color temperature of 2700K. Consequently, the ACLED may generate two levels of illuminations with high illumination and hue contrast without using a zero-crossing detection circuit.

Fifth Exemplary Embodiment

Refer to FIG. **7**, which illustrates a schematic diagram of a two-level LED security light in accordance to the fifth exemplary embodiment of the present disclosure. The light-emitting unit **750** of FIG. **7** is different from the light-emitting unit **640** of FIG. **6** in that the ACLED**3** is series-connected to a circuit with a rectified diode D and a switch **753** parallel-connected together, and of which is further coupled through a switch **751** to AC power source. When the switch **753** closes, the AC electric current that passes through the ACLED**3** may be a full sinusoidal waveform. When the switch **753** opens, the rectified diode rectifies the AC power, thus only one half cycle of the AC electric current may pass through the ACLED, consequently the luminous power of ACLED**3** is cut to be half.

The pin PS of the microcontroller **240** synchronously controls the operations of switches **752** and **753**. If the three ACLED**1~3** have identical luminous power, then in the PC mode, the pin PC and pin PS of the microcontroller **240** synchronously close the switches **751~753** to render ACLED**1~3** illuminating, thus the light-emitting unit **750** generates a high level illumination which is three-times higher than the luminous power of a single ACLED. When in the PS mode, the microcontroller **240** closes the switch **751** while opens switches **752** and **753**. At this moment, only the ACLED**3** illuminates and as the AC power source is rectified by the rectified diode D, thus the luminous power of ACLED**3** is half of the AC power source prior to the rectification. The luminous power ratio between the high level and the low level illuminations is therefore 6 to 1. Consequently, strong illumination contrast may be generated to effectively warn the intruder.

It should be noted that the light-emitting unit in the fifth exemplary embodiment is not limited to utilizing ACLEDs. In other words, the light-emitting unit may include any AC lighting sources such as ACLEDs, incandescent lamps, or fluorescent lamps.

When the light source of the light-emitting unit **150** is confined to the use of an LED load, the compliance and satisfaction of an operating constraint attributable to the unique electrical characteristics of the LED load is vital to a successful performance of an LED lighting device. Any LED lighting device failing to comply with the operating constraint of the unique electrical characteristics is bound to become a trouble art. This is because the LED as a kind of solid state light source has completely different electrical characteristics for performing light emission compared with conventional light source such as incandescent bulbs or fluorescent bulbs. For instance, for a white light or blue light LED there exists a very narrow voltage domain ranging from a minimum threshold voltage at 2.5 volts to a maximum working voltage at 3.3 volts, which allows to operate adequately and safely the LED; in other words, when a forward voltage imposed on the LED is lower than the minimum threshold voltage, the LED is not conducted and therefore no light is emitted, when the forward voltage exceeds the maximum working voltage, the heat generated by a forward current could start damaging the construction of the LED. Therefore, the forward voltage imposed on the LED is required to operate between the minimum threshold voltage and the maximum working voltage. In respect to the LED load of the light-emitting unit **150**, the cut-in voltage V_t of ACLEDs is technically also referred to as a minimum threshold voltage attributable to PN junctions manufactured in LEDs. More specifically, the LED is made with a PN junction semiconductor structure inherently featured with three unique electrical characteristics, the first characteristic is one-way electric conduction through the PN junction fabricated in the LED, the second electrical characteristic is a minimum threshold voltage V_{th} required to trigger the LED to start emitting light and the third electrical characteristic is a maximum working voltage V_{max} allowed to impose on the LED to avoid a thermal runaway to damage or burn out the semiconductor construction of the LED. The described cut-in voltage V_t has the same meaning as the above mentioned minimum threshold voltage V_{th} which is a more general term to be used for describing the second electrical characteristic of a PN junction semiconductor structure. Also because the cut-in voltage V_t is specifically tied to forming a formula to transform the minimum threshold voltage into a corresponding time phase of AC power for lighting control, it is necessary to use the term V_{th} as a neutral word for describing the LED electrical characteristics to avoid being confused with the specific application for ACLED alone. Additionally, it is to be clarified that the term V_m is related to the amplitude of the instant maximum voltage of an AC power source which has nothing to do with the third electrical characteristic V_{max} of an LED load.

An LED chip is a small piece of semiconductor material with at least one LED manufactured inside the semiconductor material. A plurality of LEDs may be manufactured and packaged inside an LED chip for different levels of wattage specification to meet different illumination need. For each LED chip designed with a different level of wattage specification there always exists a narrow voltage domain $V_{th}<V<V_{max}$, wherein V_{th} is the minimum threshold voltage to enable the LED chip to start emitting light and V_{max} is the maximum working voltage allowed to impose on the LED chip to protect the LED chip from being damaged or burned out by the heat generated by a higher working voltage exceeding V_{max}.

For an LED load configured with a plurality of the LED chips in any LED lighting device, regardless such LED load being configured with ACLED chips or DC LED chips, the working voltage of each single LED chip is required to operate in a domain between a minimum threshold voltage V_{th} and a maximum working voltage V_{max} or $V_{th}<V<V_{max}$ and the working voltage of the LED load comprising N pieces of LED chips connected in series is therefore required to operate in a domain established by a minimum threshold voltage $N\times V_{th}$ and a maximum working voltage $N\times V_{max}$ or $N\times V_{th}<V<N\times V_{max}$, wherein N is the number of the LED chips electrically connected in series. For any LED lighting device comprising an LED load it is required that the LED load in conjunction with an adequate level of power source is configured with a combination of in series and in parallel connections of LED chips such that the electric current passing through each LED chip of the LED load remains at an adequate level such that a voltage V across each LED chip complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED chip or a voltage V across the LED load configured with N number of LED chips connected in series complies with an operating constraint of $N\times V_{th}<V<N\times V_{max}$. Such narrow operating range therefore posts an engineering challenge for a circuit designer to successfully design an adequate level of power source and a reliable circuitry configured with an adequate combination of in series connection and in parallel connection of LED chips for operating a higher power LED security light.

FIGS. **8**A, **8**B, **8**C and **8**D comprises 4 drawings schematically and respectively showing a V-I relationship chart (Forward Current vs. Forward Voltage) for a white light LED chip from each of 4 different LED manufacturers; as can be seen from the chart when a forward voltage V is below a minimum forward voltage at around 2.5 volts, the LED chip is not conducted so the current I is zero, as the forward voltage exceeds 2.5 volts the LED chip is activated to generate a current flow to emit light, as the forward voltage continues to increase, the current I increases exponentially at a much faster pace, at a maximum forward voltage around 3.3 volts the current I becomes 250 mA which generates a heat that could start damaging the PN junction of the LED chip. The minimum forward voltage (the minimum threshold voltage or cut-in voltage) and the maximum forward voltage are readily available in the specification sheets at each of LED manufacturers, such as Cree, Lumileds, Samsung, Osram, and etc. Different LED manufacturers may have slightly different figures due to manufacturing process but the deviations of differences are negligible. The constraints of minimum forward voltage and maximum forward voltage represent physical properties inherent in any solid state light source. They are necessary matter for configuring any LED lighting products to ensure a normal performance of an LED load.

FIG. **9** is a data sheet showing data of the minimum forward voltages and maximum forward voltages collected from various LED manufacturers. They are fundamental requirements for configuring any LED lighting control devices to ensure a successful performance of any LED lighting device.

In summary, the compliance of voltage operating constraint $V_{th}<V<V_{max}$ featuring electrical characteristics of an LED chip is a critical technology for ensuring a normal performance of the LED load. Failing to comply with such voltage operating constraint can quickly age or seriously damage the semiconductor structure of the LED chip with a consequence of quick lumens depreciation of the LED bulbs and the product lifetime being substantially shortened, which will be unacceptable to the consumers.

The compliance of the operating constraint $V_{th}<V<V_{max}$ is a necessary matter for any LED lighting device though it is not an obvious matter as it requires complicated technologies to calculate and coordinate among an adequate level of power source, a control circuitry and a non-linear light emitting load. For conventional lighting load such as incandescent bulb there exists no such operating constraint. This is why in the past years there had been many consumers complaining about malfunction of LED bulbs that the consumers were frustrated with the fast depreciation of lumens output and substantially shortened product lifetime of the LED bulbs purchased and used. A good example was a law suit case filed by the Federal Trade Commission on Sep. 7, 2010 (Case No. SACV10-01333 JVS) for a complaint against a leading lighting manufacturer (Light of America) for marketing deceptive LED lamps and making false claims with respect to the life time of their LED lamps and a huge amount of monetary relief was claimed with the Court in the complaint.

The present disclosure of a lifestyle security light provides a unique lifestyle lighting solution. The motivation of creating such lifestyle lighting solution has less to do with the energy saving aspect of the low level illumination mode because LED is already a very energy saving light source compared with the conventional incandescent light source. For instance, a 10-watt LED security light when operated at a low level at 30% illumination it only saves 7 watts, which is not as significant as a 100-watt incandescent bulb which can save as much as 70 watts when operated at 30% illumination for a low level mode. While it is always good to save some extra energy, it is however not the main incentives for developing the present invention; the lifestyle lighting solution of the present disclosure is featured with at least three innovative advantages which meaningfully improve the exquisite tastes of living in the evening, the first innovative advantage is the creation of an aesthetic scene for the outdoor living environment, wherein at dusk the LED security light is automatically turned on by the photo sensor to perform the low level illumination which is necessary for creating a soft and aesthetic night scene for the outdoor living area, such soft and aesthetic night scene is not achievable by the high level illumination, the second innovative advantage is the creation of a navigation capacity similar to a light house effect for guiding people to safely move toward a destination in the outdoor living area without getting lost or encountering an accident, the third innovative advantage is a prevention of the light being unexpectedly and completely shutoff while a person is still in the detection area and a simple motion can bring the light back to the full illumination. These three innovative functions coupled with the motion sensor to increase illumination when people enters into the short detection area makes the present invention a perfect lifestyle lighting solution for enjoying an exquisite taste of evening life.

A lighting apparatus may be implemented by integrating a plurality of LEDs with a microcontroller and various types of sensor components in the controlling circuit in accordance to the above described five exemplary embodiments. This lighting apparatus may automatically generate high level illumination when the ambient light detected is insufficient and time-switch to the low level illumination. In addition, when a person is entering the predetermined detection zone, the lighting apparatus may switch from the low level illumination to the high level illumination, to provide

the person with sufficient illumination or to generate strong illumination and hue contrast for monitoring the intruder.

The above-mentioned descriptions represent merely the exemplary embodiment of the present disclosure, without any intention to limit the scope of the present disclosure thereto. Various equivalent changes, alternations or modifications based on the claims of present disclosure are all consequently viewed as being embraced by the scope of the present disclosure.

What is claimed is:

1. A lifestyle LED security light, comprising:

a light-emitting unit, including an LED load configured with a plurality of LEDs;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit; and

a power supply unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the controller is electrically coupled with the switching circuitry, the light sensing control unit and the motion sensing unit, wherein the switching circuitry is electrically connected between a power source and the LED load of the light-emitting unit, wherein the LED load is switched on or switched off by the light sensing control unit and controlled by the loading and power control unit, wherein the switching circuitry comprises at least a semiconductor switching device for controlling transmission of different electric powers delivered to the LED load, wherein the controller outputs control signals to control the switching circuitry for delivering different electric powers from the power source to drive the light-emitting unit for generating different illuminations characterized by different light intensities according to signals received from the light sensing control unit and the motion sensing unit;

wherein the power source configured in the power supply unit outputs a DC power for operating the LED lighting device;

wherein a time setting unit is further installed and is electrically coupled with the controller for adjusting and setting a time duration for each of the different illumination modes, wherein when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit operates to switch on the LED load to perform a first illumination mode to generate a first level illumination for a first predetermined time duration preset by the time setting unit, wherein when a motion intrusion is detected by the motion sensing unit, the loading and power control unit manages to increase the electric power transmitted to the LED load to perform a second illumination mode to generate a second level illumination for a second predetermined time duration preset by the time setting unit, wherein the light intensity of the second level illumination is higher than the light intensity of the first level illumination, wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the loading and power control unit operates to switch off the LED load;

wherein the first level illumination is a low level illumination and the second level illumination is a high level illumination, wherein during the performance of the first illumination mode, the low level illumination creates four advantages for performing a lifestyle lighting solution, wherein a first advantage is a creation of an aesthetic night scene when people are outside of a detection area of the motion sensor, wherein a second advantage is the creation of a navigation capacity similar to a light house for guiding people to safely walk to a destination in an outdoor living area, wherein a third advantage is a prevention of a hardship of light being unexpectedly and completely shutoff while a person is still in the detection space due to expiration of a timer and a simple motion by the person can immediately bring the LED security light back to the high level illumination, wherein a fourth advantage is an occupancy declaration that a living space being occupied to discourage an intrusion or break in intention.

2. The lifestyle LED security light according to claim **1**, wherein a configuration of the plurality of LEDs of the light emitting unit is designed with a combination of in series and/or in parallel connections such that when incorporated with a level setting of the DC power from the switching circuitry, an electric current passing through each LED of the LED load remains at a safety level such that a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED, wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum operating voltage across each LED to avoid a thermal damage or burning out of LED construction;

wherein when the LED load is configured with a plurality of N number LEDs or N sets of LEDs electrically connected in series, a working voltage V_N across the LED load is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs or sets of LEDs electrically connected in series, identically expressed as $N\times V_{th}<N_N<N\times V_{max}$.

3. The lifestyle LED security light according to claim **2**, wherein the LED is a white light LED having the voltage V across each LED complying with an operating constraint of 2.5 volts$<V_{th}<V<V_{max}<$3.5 volts and the working voltage V_N imposed on the LED load is thereby confined in a domain N×2.5 volts$<V_N<$N×3.5 volts.

4. The lifestyle LED security light according to claim **1**, wherein the power supply unit is configured with an AC/DC power converter to convert an AC power into a least one DC power required for operating the LED security light.

5. The lifestyle LED security light according to claim **1**, wherein the power supply unit comprises a battery module to output at least one DC power for operating the lifestyle LED security light.

6. The lifestyle LED security light according to claim **5**, wherein the battery module is a rechargeable battery module.

7. The lifestyle LED security light according to claim **6**, wherein the rechargeable battery module is a solar battery module including a solar panel, a charging circuitry and a rechargeable battery.

8. A lifestyle LED security light control device, comprising:

a loading and power control unit;

a light sensing control unit;

a motion sensing unit; and

a power supply unit;

wherein the LED security light control device is electrically connectable to an LED load configured with a plurality of LEDs, wherein the loading and power control unit comprises a controller and a switching

circuitry, wherein the controller is electrically coupled with the switching circuitry, the light sensing control unit and the motion sensing unit, wherein the switching circuitry is electrically connected between a power source and the LED load, wherein the switching circuitry comprises at least a semiconductor switching device for controlling transmission of different electric powers delivered to the LED load, wherein the controller outputs control signals to control the switching circuitry for delivering different electric powers from the power source to drive the LED load for performing at least two different illumination modes with different light intensities according to signals received from the light sensing control unit and the motion sensing unit;

wherein the power source configured in the power supply unit outputs at least one DC power for operating the LED lighting device;

wherein a time setting unit is further installed and is electrically coupled with the controller for adjusting and setting a time duration for each of the different illumination modes, wherein when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit operates to turn on the LED load to perform a first illumination mode to generate a first level illumination for a first predetermined time duration preset by the time setting unit, wherein when a motion intrusion is detected by the motion sensing unit, the loading and power control unit manages to increase the average electric power transmitted to the LED load to perform a second illumination mode to generate a second level illumination for a second predetermined time duration preset by the time setting unit, wherein the light intensity of said second level illumination is higher than the light intensity of said first level illumination, wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the loading and power control unit operates to turn off the LED load;

wherein the first level illumination is a low level illumination and the second level illumination is a high level illumination, wherein during the performance of the first illumination mode, the low level illumination creates four advantages in performing a lifestyle lighting solution, wherein a first advantage is a creation of an aesthetic night scene when people are outside of a detection area of the motion sensor, wherein a second advantage is the creation of a navigation capacity similar to a light house for guiding people to safely walk to a destination in an outdoor living area, wherein the third advantage is a prevention of a hardship of light being unexpectedly and completely shutoff due to expiration of a timer while a person is still in a detection space and a simple motion by the person can immediately bring the LED load back to the high level illumination, wherein a fourth advantage is an occupancy declaration that a living space being occupied to discourage an intrusion or break in intention.

9. The lifestyle LED security light control device according to claim **8**, wherein the plurality of LEDs are designed with a configuration of in series and/or in parallel connections such that when incorporated with a level setting of the DC power from the switching circuitry, an electric current passing through each LED of the LED load remains at a safety level such that a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED, wherein V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across the LED to avoid a thermal damage or burning out of LED construction;

wherein when the LED load is configured with a plurality of N number LEDs or N sets of LEDs electrically connected in series, a working voltage V_N across the LED load is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs or sets of LEDs electrically connected in series, identically expressed as $N\times V_{th}<V_N<N\times V_{max}$.

10. The lifestyle LED security light according to claim **9**, wherein the LED is a white light LED having the voltage V across each LED complying with an operating constraint of 2.5 volts$<V_{th}<V<V_{max}<$3.5 volts and the working voltage V_N imposed on the LED load is thereby confined in a domain N×2.5 volts$<V_N<$N×3.5 volts.

11. The lifestyle LED security light control device according to claim **8**, wherein the controller is an integrated circuit device programmable for generating the control signal.

12. The lifestyle LED security light control device according claim **8**, wherein the controller is an application specific integrated circuit customized for generating the control signal.

13. The lifestyle LED security light control device according to claim **8**, wherein the power supply unit comprises a battery module to output at least one DC power for operating the LED security light.

14. The lifestyle LED security light control device according to claim **13**, wherein the battery module is a rechargeable battery module.

15. The lifestyle LED security light control device according to claim **14**, wherein the rechargeable battery module is a solar battery module including a solar panel, a charging circuitry and a rechargeable battery.

16. A lifestyle LED security light, comprising:

a light-emitting unit, including a dimmable LED bulb;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit; and

a power supply unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the controller is electrically coupled with the switching circuitry, the light sensing control unit and the motion sensing unit, wherein the switching circuitry is electrically connected between a power source and the dimmable LED bulb of the light-emitting unit, wherein the switching circuitry comprises at least a semiconductor switching device for controlling transmission of different average electric powers delivered to the dimmable LED bulb, wherein the controller outputs control signals to control the switching circuitry for delivering different average electric powers from the power source to drive the dimmable LED bulb of the light-emitting unit for generating different illuminations with different light intensities according to signals received from the light sensing control unit and the motion sensing unit;

wherein the power supply unit includes an AC/DC power converter to convert an AC power of an AC power source into a DC power for operating the LED security light, wherein the power source is the AC power, wherein the semiconductor switching device is a phase controller containing a bidirectional semiconductor switching device, wherein the control signal is a time

delay pulse to control a conduction state of the bidirectional semiconductor switching device in each half cycle of the AC power, wherein the controller incorporating with a zero-crossing detection circuit outputs a time delay pulse with a delay time t_D lagging behind the zero-crossing point in each half cycle of the AC power source to control a conduction rate of the phase controller for delivering different average electric powers to drive the dimmable LED bulb for performing different illumination modes according to signals received from the light sensing control unit and the motion sensing unit, wherein in order to ensure a successful conduction of the dimmable LED bulb the delay time t_D is confined to operate in a time phase domain between t_0 and $1/2f-t_0$, wherein f is the frequency of the AC power source, and t_0 is a corresponding time phase of a cut-in voltage at which the dimmable LED bulb starts to emit light in each positive and negative half cycle of the AC power;

wherein a time setting unit is further installed and is electrically coupled with the controller for adjusting and setting a time duration for each of various illumination modes, wherein when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit operates to turn on the dimmable LED bulb to perform a first illumination mode to generate a first level illumination for a first predetermined time duration preset by the time setting unit, wherein when a motion intrusion is detected by the motion sensing unit, the loading and power control unit operates to increase the average electrical power transmitted to the dimmable LED bulb to perform a second illumination mode to generate a second level illumination for a second predetermined time duration preset by the time setting unit, wherein a light intensity of the second level illumination is higher than the light intensity of the first level illumination, wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the loading and power control unit manages to turn off the dimmable LED bulb;

wherein the first level illumination is a low level illumination and the second level illumination is a high level illumination, wherein during a performance of the first illumination mode, the low level illumination creates four advantages in performing a lifestyle lighting solution, wherein a first advantage is a creation of an aesthetic night scene when people are outside of a detection area of the motion sensor, wherein a second advantage is the creation of a navigation capacity similar to a light house for guiding people to safely walk to a destination in an outdoor living area, wherein a third advantage is a prevention of a hardship of light being unexpectedly and completely shutoff due to expiration of a timer while a person is still in a detection space and a simple interruption motion can bring the LED security light back to the high level illumination, wherein a fourth advantage is an occupancy declaration that a living space being occupied to discourage an intrusion or break in intention.

17. The lifestyle LED security light according to claim **16**, wherein the controller is an integrated circuit device programmable for generating the control signal.

18. The lifestyle LED security light according to claim **16**, wherein the controller is an application specific integrated circuit customized for generating the control signal.

19. The lifestyle LED security light according to claim **16**, wherein the dimmable LED bulb comprises at least a full wave rectifier and a DC LED module configured with a plurality of LEDs, wherein the full wave rectifier converts the AC power delivered by the phase controller into a DC power, wherein the plurality of LEDs of the DC LED module are designed to be a combination of in parallel and/or in series connections of N number LEDs or N sets of LEDs, where N is a positive integer, for matching with the DC power converted by the full-wave rectifier such that an average electric current passing through each LED of the DC LED module remains at a safety level and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED, wherein V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across the LED to avoid a thermal damage or burning out of LED construction;

wherein when the DC LED module is configured with N number LEDs or N sets of LEDs electrically connected in series, a working voltage V_N across the DC LED module is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs or sets of LEDs electrically connected in series, identically expressed as $N\times V_{th}<V_N<N\times V_{max}$.

20. The lifestyle LED security light according to claim **19**, wherein the LED is a white light LED having the voltage V across each LED complying with an operating constraint of 2.5 volts$<V_{th}<V<V_{max}<$3.5 volts and the working voltage V_N imposed on the DC LED module is thereby confined in a domain $N\times2.5$ volts$<V_N<N\times3.5$ volts.

21. The lifestyle LED security light according to claim **16**, wherein the dimmable LED bulb comprises at least an AC LED module containing two polarity reverse LED arrays connected in parallel, wherein each of the two polarity reverse LED arrays is configured with a plurality of LEDs, wherein the plurality of LEDs are designed to be a combination of in parallel and/or in series connections of N number LEDs or N sets of LEDs, where N is a positive integer, for matching with the AC power delivered by the phase controller such that an electric current passing through each LED of the two polarity reverse LED arrays remains at a safety level and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED, wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum operating voltage across each LED to avoid a thermal damage or burning out of LED construction;

wherein when each of two polarity reverse LED arrays is configured with N number LEDs or N sets of LEDs electrically connected in series, a working voltage V_N across each of the two polarity reverse LED arrays is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs or sets of LEDs electrically connected in series, identically expressed as $N\times V_{th}<V_N<N\times V_{max}$.

22. The lifestyle LED security light according to claim **21**, wherein the LED is a white light LED having the voltage V across each LED complying with an operating constraint of 2.5 volts$<V_{th}<V<V_{max}<$3.5 volts and the working voltage

V_N imposed on each of two polarity reverse LED arrays is thereby confined in a domain N×2.5 volts<V_N<N×3.5 volts.

23. A lifestyle LED security light control device, comprising:

a loading and power control unit;

a light sensing control unit;

a motion sensing unit; and

a power supply unit;

wherein the lifestyle LED security light control device is to be electrically connected to a dimmable LED bulb, wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the controller is electrically coupled with the switching circuitry, the light sensing control unit and the motion sensing unit, wherein the switching circuitry is electrically connected between a power source and the dimmable LED bulb, wherein the controller outputs control signals to control the switching circuitry for delivering different average electric powers from the power source to the dimmable LED bulb for generating different illuminations, wherein the controller controls the switching circuitry to deliver different average electric powers to the dimmable LED bulb such that the LED security light respectively performs at least two illumination modes with different light intensities according to signals received from the light sensing control unit and the motion sensing unit;

wherein the power supply unit includes an AC/DC power converter to convert an AC power of an AC power source into a DC power for operating the LED security light, wherein the power source is the AC power source, wherein the switching circuitry includes a phase controller containing a bidirectional semiconductor switching device, wherein the bidirectional semiconductor switching device is electrically connected in series between the AC power source and the dimmable LED bulb, and wherein the controller incorporated with a zero-crossing point detection circuit outputs a time delay pulse with a delay time t_D lagging behind the zero-crossing point in each half cycle of the AC power source to control the conduction rate of the phase controller for delivering different average AC power to the dimmable LED bulb for performing different illumination modes according to signals received from the light sensing control unit and the motion sensing unit;

wherein in order to ensure a successful conduction of the dimmable LED bulb the delay time t_D is confined to operate in a time phase domain between t_0 and $1/2f-t_0$, wherein f is the frequency of the AC power source, and t_0 is a corresponding time phase of a cut-in voltage at which the dimmable LED bulb starts to emit light in each positive and negative half cycle of the AC power;

wherein a time setting unit is further installed and is electrically coupled with the controller for adjusting and setting a time duration for each of the different illumination modes, wherein when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit operates to perform a first illumination mode to generate a first level illumination for a first predetermined time duration preset by the time setting unit, wherein when a motion intrusion is detected by the motion sensing unit, the loading and power control unit operates to increase the average electric power transmitted to the dimmable LED bulb to perform a second illumination mode to generate a second level illumination for a second predetermined time duration preset by the time setting unit, wherein a light intensity of said second illumination mode is higher than the light intensity of said first illumination mode, wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the loading and power control unit operates to turn off the dimmable LED bulb;

wherein the first level illumination is a low level illumination and the second level illumination is a high level illumination, wherein during the performance of the first illumination mode, the low level illumination creates four advantages in performing a lifestyle lighting solution, wherein a first advantage is a creation of an aesthetic night scene when people are outside of a detection area of the motion sensor, wherein a second advantage is the creation of a navigation capacity similar to a light house for guiding people to safely walk to a destination in an outdoor living area, wherein the third advantage is a prevention of a hardship of light being unexpectedly and completely shutoff due to expiration of a timer while a person is still in a detection space, wherein a fourth advantage is an occupancy declaration that a living space being occupied to discourage an intrusion or break in intention.

24. The lifestyle LED security light control device according to claim **23**, wherein the controller is an integrated circuit device programmable for generating the control signal.

25. The lifestyle LED security light control device according claim **23**, wherein the controller is an application specific integrated circuit customized for generating the control signal.

26. The lifestyle LED security light control device according to claim **23**, wherein the dimmable LED bulb comprises at least a full wave rectifier, and a DC LED module configured with a plurality of LEDs, wherein the full wave rectifier converts the AC power delivered by the phase controller into a DC power, wherein the plurality of LEDs of the DC LED module are designed to be a combination of in parallel and/or in series connections of N number LEDs or N sets of LEDs, where N is a positive integer, for matching with the DC power converted by the full-wave rectifier such that an average electric current passing through each LED of the DC LED module remains at a safety level and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED, wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum operating voltage across each LED to avoid a thermal damage or burning out of LED construction;

wherein when the DC LED module is configured with a plurality of N number LEDs or N sets of LEDs electrically connected in series, a working voltage V_N across the DC LED module is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs or sets of LEDs electrically connected in series, identically expressed as $N\times V_{th}<V_N<N\times V_{max}$.

27. The lifestyle LED security light control device according to claim **26**, wherein the LED is a white light LED having the voltage V across each LED complying with an operating constraint of 2.5 volts<V_{th}<V<V_{max}<3.5 volts and the working voltage V_N imposed on the DC LED module is thereby confined in a domain N×2.5 volts<V_N<N×3.5 volts.

28. The lifestyle LED security light control device according to claim **23**, wherein the dimmable LED bulb comprises at least an AC LED module configured with two polarity reverse LED arrays connected in parallel, wherein each of the two polarity reverse LED arrays is designed to be a combination of in series and/or in parallel connections of N number LEDs or N sets of LEDs, where N is a positive integer, for matching with the AC power delivered by the phase controller such that an electric current passing through each LED remains at a safety level and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED, wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum operating voltage across each LED to avoid a thermal damage or burning out of LED construction;

wherein when each of the two polarity reverse LED arrays is configured with N number LEDs or N sets of LEDs electrically connected in series, a working voltage V_N across each LED array is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs or sets of LEDs electrically connected in series, identically expressed as $N\times V_{th}<V_N<N\times V_{max}$.

29. The lifestyle LED security light control device according to claim **28**, wherein the LED is a white light LED having the voltage V across each LED complying with an operating constraint of 2.5 volts$<V_{th}<V<V_{max}<$3.5 volts and the working voltage V_N imposed on of the two polarity reverse LED arrays is thereby confined in a domain N×2.5 volts$<V_N<$N×3.5 volts.

30. A method of dimming an LED light bulb powered by an AC power, comprising:

using a phase controller electrically coupled between an AC power and the LED light bulb to control a transmission of an average electric power delivered to the LED light bulb;

using a zero crossing point detection circuit to identify a zero crossing point information in each AC half cycle;

using a controller incorporating with the zero-crossing point detection circuit to output a time delay pulse with a delay time t_D lagging behind the zero-crossing point in each half cycle of the AC power to control a conduction rate of the phase controller for delivering an average electric power to the LED light bulb for generating an illumination, wherein in order to ensure a successful conduction of the LED light bulb the delay time t_D is confined to operate in a time phase domain between t_0 and $1/2f-t_0$, wherein f is the frequency of the AC power source, and t_0 is a corresponding time phase of a cut-in voltage of the LED light bulb at which the LED light bulb starts emitting light; and

using an external control device to output an external control signal to the controller to accordingly output the time delay pulse to control the conduction rate of the phase controller;

wherein the phase controller contains a bidirectional semiconductor switching device, wherein the LED light bulb comprises at least a full wave rectifier, a driving circuitry and a DC LED module configured with a plurality of light emitting diodes electrically coupled with the full wave rectifier, wherein the full wave rectifier converts the AC power delivered by the phase controller into a DC power, wherein the driving circuitry further transforms the DC power delivered by the full wave rectifier into an adequate DC power level for driving the DC LED module for generating the illumination;

wherein the plurality of LEDs of the DC LED module are designed to be a combination of in parallel and/or in series connections such that when incorporated with the adequate DC power provided by the driving circuitry an average electric current passing through each LED of the DC LED module remains at a safety level and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED, wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum operating voltage across each LED to avoid a thermal damage or burning out of LED construction.

31. A method of dimming an LED light bulb powered by an AC power, comprising:

using a phase controller electrically coupled between an AC power source and an LED light bulb to control a transmission of an average electric power delivered to the LED load;

using a zero crossing point detection circuit to identify a zero crossing point in each half cycle of the AC power;

using a controller incorporating with the zero-crossing point detection circuit to output a time delay pulse with a delay time t_D lagging behind the zero-crossing point in each half cycle of the AC power to control a conduction rate of the phase controller for delivering an average electric power to drive the LED light bulb for generating an illumination, wherein in order to ensure a successful conduction of the phase controller the delay time t_D is confined to operate in a time phase domain between t_0 and $1/2f-t_0$, wherein f is the frequency of the AC power source, and t_0 is a corresponding time phase of a cut-in voltage at which the LED load starts to emit light in each positive and negative half cycle of the AC power; and

using an external control device to output an external control signal to the controller to accordingly output the time delay pulse to control the conduction rate of the phase controller;

wherein the phase controller contains a bidirectional semiconductor switching device, wherein the LED light bulb further comprises at least a driving circuitry and an AC LED module configured with two polarity reverse LED arrays connected in parallel, wherein the driving circuitry transforms the AC power delivered by the phase controller into an adequate power levels for driving the AC LED module for generating the illuminations, wherein a first LED array conducts in a positive half cycle while a second LED array conducts in a negative half cycle;

wherein each of the two polarity reverse LED arrays is designed to be a combination of in series and/or in parallel connections such that when incorporated with the adequate DC power provided by the driving circuitry an electric current passing through each LED remains at a safety level and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of each LED, wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum operating voltage across each LED to avoid a thermal damage or burning out of LED construction;

wherein when each of the two polarity reverse LED arrays is configured with a plurality of N number LEDs or N

sets of LEDs electrically connected in series, a working voltage V_N across each of the two LED arrays is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs or sets of LEDs electrically connected in series, identically expressed as $N \times V_{th} < V_N < N \times V_{max}$.

32. A lifestyle LED security light control device, comprising:

a loading and power control unit;

a light sensing control unit;

a motion sensing unit;

a power supply unit; and

a time setting unit;

wherein the lifestyle LED security light control device is to be electrically connected to a dimmable LED bulb;

wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the controller is electrically coupled with the switching circuitry, the light sensing control unit and the motion sensing unit, wherein the switching circuitry is electrically connected between a power source and the dimmable LED bulb, wherein the switching circuitry comprises at least a semiconductor switching device for controlling a transmission of an electric power delivered to the dimmable LED bulb, wherein the controller outputs a control signal to control a conduction rate of the switching circuitry for delivering at least one electric power from the power source to drive the dimmable LED bulb for generating at least one illumination according to signals received from the light sensing control unit and the motion sensing unit;

wherein the power supply unit includes an AC/DC power converter to convert an AC power of an AC power source into a DC power for operating the lifestyle LED security light, wherein the power source is the AC power source, wherein the semiconductor switching device is a phase controller containing a bidirectional semiconductor switching device, wherein the control signal is a time delay pulse to control a conduction state of the bidirectional semiconductor switching device in each half cycle of the AC power, wherein the controller incorporating with a zero-crossing point detection circuit outputs the time delay pulse with a delay time t_D lagging behind the zero-crossing point in each half cycle of the AC power to control a conduction rate of the phase controller for delivering at least one average electric power to drive the dimmable LED bulb for generating at least one illumination according to signals received from the light sensing control unit and the motion sensing unit, wherein in order to ensure a successful conduction of the dimmable LED bulb the delay time t_D is confined to operate in a time phase domain between t_0 and $1/2f-t_0$, wherein f is the frequency of the AC power source, and t_0 is a corresponding time phase of a cut-in voltage of the lifestyle LED security light due to the dimmable LED bulb at which the dimmable LED bulb starts to emit light in each positive and negative half cycle of the AC power;

wherein the time setting unit is electrically coupled with the controller and is used for adjusting and setting a predetermined time duration for an illumination activated by the motion sensing unit;

wherein when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit operates to activate the motion sensing unit; wherein when a motion intrusion is detected by the motion sensing unit, the loading and power control unit manages to deliver an average electric power to the dimmable LED bulb to generate the illumination for the predetermined time duration preset by the time setting unit;

wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the loading and power control unit operates to switch off the dimmable LED bulb.

33. The lifestyle LED security light control device according to claim **32**, wherein the controller is an integrated circuit device programmable for generating the control signal.

34. The lifestyle LED security light control device according to claim **32**, wherein the controller is an application specific integrated circuit customized for generating the control signal.

35. The lifestyle LED security light control device according to claim **32**, wherein the dimmable LED bulb comprises at least a full wave rectifier, a driving circuitry and a DC LED module configured with a plurality of LEDs, wherein the plurality of LEDs of the DC LED module are designed to be a combination of in parallel and/or in series connections such that when incorporated with an adequate DC power from the driving circuitry an average electric current passing through each LED of the DC LED module remains at a safety level and a voltage V across each LED complies with an operating constraint of $V_{th} < V < V_{max}$ featuring electrical characteristics of each LED, wherein V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across each LED to avoid a thermal damage or burning out of LED construction;

wherein when the DC LED module is configured with a plurality of N number LEDs or N sets of LEDs electrically connected in series, a working voltage V_N across each of the two LED arrays is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs or sets of LEDs electrically connected in series, identically expressed as $N \times V_{th} < V_N < N \times V_{max}$.

36. The lifestyle LED security light control device according to claim **35**, wherein the LED is a white light LED having the voltage V across each LED complying with an operating constraint of 2.5 volts$< V_{th} < V < V_{max} <$3.5 volts and the working voltage V_N imposed on of the two polarity reverse LED arrays is thereby confined in a domain $N \times 2.5$ volts$< V_N < N \times 3.5$ volts.

37. The lifestyle LED security light control device according to claim **32**, wherein the dimmable LED bulb comprises at least a driving circuitry and an AC LED module configured with two polarity reverse LED arrays connected in parallel, wherein the driving circuitry transforms the AC power delivered by the phase controller into an adequate power level for driving the AC LED module for generating the illumination.

38. The lifestyle LED security light control device according to claim **37**, wherein each of the two polarity reverse LED arrays is designed to be a combination of in series and/or in parallel connections such that when incorporated with the adequate DC power from the driving circuitry an electric current passing through each LED of each LED array remains at a level and a voltage V across each LED complies with an operating constraint of $V_{th} < V < V_{max}$ fea-

turing electrical characteristics of each LED, wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum operating voltage across each LED to avoid a thermal damage or burning out of LED construction;

wherein when each of the two polarity reverse LED arrays is configured with a plurality of N number LEDs or N sets of LEDs electrically connected in series, a working voltage V_N across each LED array is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs or sets of LEDs electrically connected in series, identically expressed as $N \times V_{th} < V_N < N \times V_{max}$.

39. A lifestyle LED lighting device, comprising:

a light-emitting unit comprising at least two LED lighting loads emitting lights with different color temperatures including at least a first LED lighting load emitting light with a low color temperature and a second LED lighting load emitting light with a high color temperature;

a light diffuser to cover the at least two LED lighting loads emitting lights with different color temperatures to create a diffused light with a mixed color temperature;

a loading and power control unit comprising at least a controller, a switching circuitry, and a power allocation circuitry;

a light sensing control unit;

a motion sensing unit;

a power supply unit; and

an external control unit, comprising at least a first external control device to manage the power allocation circuitry for selecting a desired mixed color temperature;

wherein the controller is electrically coupled with the switching circuitry, the light sensing control unit and the motion sensing unit, wherein the switching circuitry is electrically coupled between a power source and the light-emitting unit, wherein the power allocation circuitry is installed between the switching circuitry and the at least two LED lighting loads respectively for managing a power allocation of an electric power controlled by the switching circuitry respectively delivered to the first LED lighting load and the second LED lighting load to determine a selection of the mixed color temperature, wherein the light-emitting unit is switched on or switched off by the light sensing control unit and controlled by the loading and power control unit, wherein the controller outputs a control signal to control the switching circuitry for delivering the electric power from the power source to drive the light-emitting unit for generating an illumination with a selected color temperature according to signals received from the light sensing control unit and the motion sensing unit;

wherein the power source configured in the power supply unit outputs a DC power for operating the LED lighting device, wherein a time setting unit is further installed for adjusting and setting a predetermined time duration for the illumination activated by the motion sensing unit, wherein when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit operates to activate the motion sensing unit, wherein when a motion signal is detected by the motion sensing unit, the loading and power control unit manages to deliver the electric power to the light-emitting unit to perform the illumination with the selected color temperature for the predetermined time duration set by the time setting unit, wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the loading and power control unit operates to switch off the light-emitting unit.

40. The lifestyle LED lighting device according to claim **39**, wherein the LEDs of the first LED lighting load and the LEDs of the second LED lighting load are respectively designed with a configuration of in series and/or in parallel connections such that when incorporated with an adequate level setting of the DC power from the switching circuitry an electric current passing through each LED of the first LED lighting load and each LED of the second LED lighting load remains at a level such that a voltage V across each LED complies with an operating constraint of $V_{th} < V < V_{max}$ featuring electrical characteristics of a LED, where V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across the LED to avoid a thermal damage or burning out of LED construction;

wherein when each of the first LED lighting load and the second LED lighting load is configured with a plurality of N number LEDs or N sets of LEDs electrically connected in series, a working voltage V_N across each of the first LED lighting load and the second LED lighting load is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs or sets of LEDs electrically connected in series, identically expressed as $N \times V_{th} < V_N < N \times V_{max}$.

41. The lifestyle LED security light control device according to claim **40**, wherein the LED is a white light LED having the voltage V across each LED complying with an operating constraint of 2.5 volts$< V_{th} < V < V_{max} <$3.5 volts and the working voltage V_N imposed on of the two polarity reverse LED arrays is thereby confined in a domain N×2.5 volts$< V_N <$N×3.5 volts.

42. The lifestyle LED lighting device according to claim **39**, wherein the power allocation circuitry is configured to operate with at least two loading options respectively corresponding to two selections of different mixed color temperatures; wherein a first loading option includes only the first LED lighting load being connected to the switching circuitry to receive the electric power outputted by the switching circuitry for generating an illumination with the low color temperature, wherein a second loading option includes only the second LED lighting load being connected to the switching circuitry to receive the electric power outputted by the switching circuitry for generating an illumination with the high color temperature, wherein the power allocation circuitry is designed with a selection switch configured with at least two switching positions including a first switching position and a second switching position, wherein the selection switch is the first external control device operable by a user for respectively connecting the switching circuitry to operate the at least two loading options, wherein when the selection switch is connected to the first switching position for operating the first loading option, the switching circuitry is connected to the first LED lighting load to deliver the electric power to the first LED lighting load, wherein when the selection switch is connected to the second switching position for operating the second loading option, the switching circuitry is connected

to the second LED lighting load to deliver the electric power to the second LED lighting load.

43. The lifestyle LED lighting device according to claim **42**, wherein the selection switch is a slide switch configured with the at least two switching positions to respectively connect the switching circuitry to the first LED lighting load and the second LED lighting load.

44. The lifestyle LED lighting device according to claim **42**, wherein the selection switch is a rotary switch configured with the at least two switching positions to respectively connect the switching circuitry to the first LED lighting load and the second LED lighting load.

45. The lifestyle LED lighting device according to claim **39**, wherein the switching circuitry is an LED driver outputting a constant electric current, wherein the power allocation circuitry is configured to operate with at least three loading options respectively corresponding to three selections of different mixed color temperatures; wherein a first loading option includes only the first LED lighting load being connected to the switching circuitry to receive the electric power delivered by the switching circuitry for generating an illumination with the low color temperature, wherein a second loading option includes only the second LED lighting load being connected to the switching circuitry to receive the electric power delivered by the switching circuitry for generating an illumination with the high color temperature, wherein a third loading option includes both the first LED light load and the second LED lighting load being connected to the switching circuitry to receive the electric power delivered by the switching circuitry for generating an illumination with a medium color temperature between the low color temperature and the high color temperature, wherein the power allocation circuitry is designed with a selection switch configured with at least three switching positions respectively for operating the at least three loading options, wherein when the selection switch is connected to the first switching position for operating the first loading option, the electric power delivered by the switching circuitry is delivered to the first LED lighting load to generate the illumination with the low color temperature, wherein when the selection switch is connected to the second switching position for operating the second loading option, the electric power delivered by the switching circuitry is delivered to the second LED lighting load to generate the illumination with the high color temperature, wherein when the selection switch is connected to the third switching position for operating the third loading option, the switching circuitry is connected to both the first LED lighting load and the second LED lighting load and the electric power delivered by the switching circuitry is delivered to both the first LED lighting load and the second LED lighting load to generate the illumination with the medium color temperature.

46. The lifestyle LED lighting device according to claim **45**, wherein the selection switch is a slide switch configured with the at least three switching positions to respectively connect the switching circuitry to the first LED lighting load, the second LED lighting load and both the first LED lighting load and the second LED lighting load.

47. The lifestyle LED lighting device according to claim **45**, wherein the selection switch is a rotary switch configured with the at least three switching positions to respectively connect the switching circuitry to the first LED lighting load, the second LED lighting load and both the first LED lighting load and the second LED lighting load.

48. The lifestyle LED lighting device according to claim **39**, wherein the power allocation circuitry is electrically and respectively coupled to two LED lighting loads emitting lights with different color temperatures, wherein the power allocation circuitry comprises at least a first switching device electrically coupled between the switching circuitry and at least one of the two LED lighting loads emitting lights with different color temperatures, wherein the controller is further electrically coupled with the first external control device and the first switching device.

49. The lifestyle LED lighting device according to claim **48**, wherein the first switching device is a two-way relay electrically coupled to two LED lighting loads, wherein when the first external control device outputs a first external control signal to the controller, the controller responsively outputs a first control signal to manage the two-way relay to connect the switching circuitry to the first LED lighting load and the LED lighting device consequently operates to perform the illumination with the low color temperature whenever activated by the motion sensing unit, wherein when the first external control devices outputs a second external control signal to the controller, the controller responsively outputs a second control signal to manage the two-way relay to redirect the switching circuitry to connect to the second LED lighting load and the LED lighting device consequently operates to perform the illumination with the high color temperature whenever activated by the motion sensing unit.

50. The lifestyle LED lighting device according to claim **48**, wherein the first switching device is a first semiconductor switching device electrically coupled between the switching circuitry and the first LED lighting load, wherein a second switching device being a second semiconductor switching device is further installed and is electrically coupled between the switching circuitry and the second LED lighting load, wherein the second semiconductor switching device is also electrically coupled with the controller, wherein the power allocation circuitry includes the first semiconductor switching device and the second semiconductor switching device and is operated by a power allocation process designed to distribute and allocate the electric power delivered by the switching circuitry into a first electric power delivered to the first LED lighting load and a second electric power delivered to the second LED lighting load for adjusting and setting the mixed color temperature of the LED lighting device when activated by the motion sensing unit;

wherein for tuning the mixed color temperature to a lower color temperature, the controller upon receiving the at least one first external control signal operates to increase a conduction rate of the first semiconductor switching device to increase the first electric power delivered to the first LED lighting load and at the same time operates to decrease the conduction rate of the second semiconductor switching device to proportionally decrease the second electric power delivered to the second LED lighting load;

wherein for tuning the mixed color temperature to a higher color temperature, the controller upon receiving the at least one first external control signal operates to decrease the conduction rate of the first semiconductor switching device to decrease the first electric power delivered to the first LED lighting load and at the same time operates to increase the conduction rate of the second semiconductor switching device to proportionally increase the electric power delivered to the second LED lighting load.

51. The lifestyle LED lighting device according to claim **50**, wherein the controller is designed with a color temperature switching scheme, wherein paired combinations of the

first electric power delivered to the first LED lighting load and the second electric power delivered to the second LED lighting load for creating different mixed color temperatures are preprogrammed and stored in a memory unit addressable by the controller for operating a pick and play process according to the at least one first external control signal generated by the first external control device for performing a selected mixed color temperature.

52. The lifestyle LED lighting device according to claim **51**, wherein the at least one first external control signal is a short power interruption signal generated by a main power switch, a push button or a touch sensor, wherein a power interruption detection circuit is electrically coupled with the controller, wherein when a power interruption signal is detected by the power interruption detection circuit and converted into a message sensing signal interpretable by the controller, the controller operates to alternately perform a color temperature performance in the color temperature switching scheme according to a prearranged sequence.

53. The lifestyle LED lighting device according to claim **52**, wherein when the main power switch is used for generating the short power interruption signal, the main power switch is turned off and turned back on within a predetermined time interval.

54. The lifestyle LED lighting device according to claim **52**, wherein when the push button or the touch sensor is used for generating the short power interruption signal, a signal detection circuitry is connected to the push button switch or the touch sensor, wherein when the push button switch or the touch sensor is operated for a short time interval a voltage signal with a time length equal to the short time interval is transmitted to the signal detection circuitry and the signal detection circuitry accordingly manages to transmit the short power interruption signal to the power interruption detection circuit for converting to the message sensing signal interpretable by the controller, the controller accordingly operates to alternately perform a color temperature performance in the color temperature switching scheme according to a prearranged sequence.

55. The lifestyle LED lighting device according to claim **51**, wherein the first external control device is a voltage divider operated by a user to output at least two voltage signals interpretable by the controller for executing the pick and play process for selecting and performing a corresponding color temperature performance in the color temperature switching scheme.

56. The lifestyle LED lighting device according to claim **55**, wherein the voltage divider is operated with a configuration of a slide switch or a rotary switch designed with a plurality of switching positions operable by a user for selecting and performing a corresponding color temperature performance from the color temperature switching scheme.

57. The lifestyle LED lighting device according to claim **51**, wherein the first external control device is a wireless signal receiver electrically coupled with the controller to receive a wireless external control signal, wherein the at least one first external control signal is at least one wireless external control signal convertible to at least one message sensing signal with a signal format interpretable by the controller for activating the pick and play process to select and perform a corresponding color temperature performance in the color temperature switching scheme.

58. The lifestyle LED lighting device according to claim **51**, wherein the at least one first external control signal is an infrared light reflected from an object entering and staying in a detection zone, wherein the first external control device is an active infrared ray sensor for detecting the infrared light reflected from the object and converting the infrared light reflected from the object into the at least one message sensing signal with a signal format interpretable by the controller for executing the pick and play process for selecting and performing a corresponding light color temperature performance from the color temperature switching scheme.

59. The lifestyle LED lighting device according to claim **51**, wherein the color temperature switching scheme comprises at least a high color temperature performance and a low color temperature performance, wherein for performing the high color temperature performance the electric power is delivered to the second LED lighting load, wherein for performing the low color temperature performance the electric power is delivered to the first LED lighting load.

60. The lifestyle LED lighting device according to claim **51**, wherein the color temperature switching scheme comprises at least a high color temperature performance, a low color temperature performance and a medium color temperature performance, wherein for performing the high color temperature performance the electric power is delivered to the second LED lighting load, wherein for performing the low color temperature performance the electric power is delivered to the first LED lighting load, wherein for performing the medium color temperature performance the electric power is distributed and respectively delivered to the first LED lighting load and the second LED lighting load.

61. The lifestyle LED security light according to claim **48**, wherein the at least one switching device is electrically connected between the switching circuitry and the second LED lighting load, wherein the controller is further installed to be electrically coupled with the first external control device and the first switching device, wherein the first external control device outputs at least one first external control signal to the controller, wherein when the controller receives the at least one first external control signal from the first external control device, the controller responsively outputs at least one first control signal to control a conduction state of the first switching device to manage the power allocation circuitry to respectively deliver the first electric power to the first LED lighting load and the second electric power to the second LED lighting load according to the power allocation algorithm for adjusting and setting the mixed light color temperature; wherein when the first switching device is cut off, the electric power is delivered to the first LED lighting load to generate the illumination with the low color temperature; wherein when the first switching device is conducted, the electric power is allocated between the first LED lighting load and the second LED lighting load to generate the illumination with a medium light color temperature.

62. The lifestyle LED security light according to claim **38**, wherein the switching circuitry is an LED driver outputting a constant electric current.

63. An LED security light, comprising:

a power supply unit;

a light-emitting unit, including an LED load configured with a plurality of LEDs;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit, including at least one motion sensor; and

a time setting unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the con-

troller is electrically coupled with the switching circuitry, the light sensing control unit and the motion sensing unit;

wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the light-emitting unit;

wherein the LED load is switched on or switched off by the light sensing control unit and controlled by the loading and power control unit, wherein the switching circuitry comprises at least one semiconductor switching device, wherein the power source configured in the power supply unit outputs a DC power for operating the LED lighting device;

wherein the controller outputs control signals to control the at least one semiconductor switching device of the switching circuitry for delivering different average electric powers from the power supply unit to drive the LED load of the light-emitting unit such that the light-emitting unit respectively generates illuminations of different light intensities for performing different illumination modes for respective predetermined time durations activated by the light sensing control unit, the motion sensing unit and the time setting unit;

wherein the time setting unit is electrically coupled with the controller and is used for adjusting and setting at least a time length of the predetermined time durations;

wherein at dusk when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit operates to activate the motion sensing unit and the light-emitting unit;

wherein when a motion signal is detected by the motion sensing unit, the loading and power control unit manages to turn on the light-emitting unit to generate a high level illumination for a predetermined time duration;

wherein upon a maturity of the predetermined time duration, the loading and power control unit manages to turn off the light-emitting unit thru a delay shutoff process, wherein the delay shutoff process is designed with a two-stage approach; wherein for the first stage of the delay shut off process, the loading and power control unit manages to drop the illumination of the light-emitting unit to a noticeably lower level and continues the noticeably lower level illumination for a short time period, wherein upon a maturity of the short time period the loading and power control unit manage to turn off the light-emitting unit;

wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the light-emitting unit is turned off by the controller;

wherein the LED load in conjunction with an adequate level of the DC power from the switching circuitry is designed with an adequate combination of in series and in parallel connections of LEDs such that an electric current passing through each LED of the LED load remains at an adequate level, and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED, where V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across the LED to avoid a thermal damage or burning out of LED construction;

wherein when the LED load is configured with a plurality of N number LEDs or N sets of LEDs electrically connected in series, a working voltage V_N across the LED load is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs or sets of LEDs electrically connected in series, identically expressed as $N\times V_{th}<V_N<N\times V_{max}$;

wherein the controller comprises at least a programmable integrated circuit device or an application specific integrated circuit.

64. The LED security light according to claim **63**, wherein the LED is a white light LED having the voltage V across each LED complying with an operating constraint of 2.5 volts$<V_{th}<V<V_{max}<$3.5 volts and the working voltage V_N imposed on the LED load is thereby confined in a domain N×2.5 volts$<V_N<$N×3.5 volts.

65. The LED security light according to claim **63**, wherein during the delay shutoff off process if a new motion signal is further detected by the motion sensing unit indicating an occupant remaining in the detection area, the loading and power control unit manages resume the high level illumination and to restart a new cycle of the high level illumination for a new predetermined time duration;

wherein during the delay shutoff process if no further motion signal is received, indicating the detection area is unoccupied, the light-emitting unit is thereby successfully turned off.

66. The LED security light according to claim **65**, wherein the new predetermined time duration is equal to the predetermined time duration used prior to restarting the new cycle of the high level illumination.

67. The LED security light according to claim **65**, wherein the new predetermined time duration is programmed to be longer than the predetermined time duration used prior to restarting the new cycle of the high level illumination according to a programmed combination of increasing delay times.

68. The LED security light according to claim **63**, wherein the power supply unit is configured with an AC/DC power converter to convert an AC power into a least one DC power required for operating the LED security light.

69. The LED security light according to claim **63**, wherein the power supply unit comprises a battery module to output at least one DC power for operating the lifestyle LED security light.

70. The LED security light according to claim **69**, wherein the battery module is a rechargeable battery module.

71. The LED security light according to claim **70**, wherein the rechargeable battery module is a solar battery module including a solar panel, a charging circuitry and a rechargeable battery.

72. A lifestyle LED security light, comprising:

a power supply unit;

a light-emitting unit, including an LED load configured with a plurality of LEDs;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit, including at least one motion sensor; and

a time setting unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, and the controller is electrically coupled with the switching circuitry, the light sensing control unit and the motion sensing unit;

wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the light-emitting unit;

wherein the LED load is switched on or switched off by the light sensing control unit and controlled by the loading and power control unit, wherein the switching circuitry comprises at least one semiconductor switching device, wherein the power source configured in the power supply unit outputs a DC power for operating the LED lighting device;

wherein the controller outputs control signals to control the at least one semiconductor switching device of the switching circuitry for delivering different average electric powers from the power supply unit to drive the LED load of the light-emitting unit such that the light-emitting unit respectively generates illuminations of different light intensities for performing different illumination modes for respective predetermined time durations activated by the light sensing control unit, the motion sensing unit and the time setting unit;

wherein the time setting unit is electrically coupled with the controller and is used for adjusting and setting at least a time length of the predetermined time durations;

wherein at dusk when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit operates to switch on the light-emitting unit to generate a low level illumination;

wherein when a motion signal is detected by the motion sensing unit, the loading and power control unit manages to increase the electric power delivered to the light-emitting unit to generate a high level illumination for a predetermined time duration;

wherein upon a maturity of the predetermined time duration, the loading and power control unit manages to reduce the electric power delivered to the light emitting unit to resume the low level illumination; wherein if a new motion signal is further detected within a short time period since a resumption of the low level illumination indicating at least one occupant remaining in the detection area, the loading and power control unit manages to resume the high level illumination for a new predetermined time duration, wherein the new predetermined time duration is programmed to be longer than the predetermined time duration used prior to restarting the new cycle of the high level illumination according to a programmed combination of increasing delay times;

wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the light-emitting unit is turned off by the controller;

wherein the LED load in conjunction with an adequate level of the DC power from the switching circuitry is designed with an adequate combination of in series and in parallel connections of LEDs such that an electric current passing through each LED of the LED load remains at an adequate level, and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED, where V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across the LED to avoid a thermal damage or burning out of LED construction;

wherein when the LED load is configured with a plurality of N number LEDs or N sets of LEDs electrically connected in series, a working voltage V_N across the LED load is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs or sets of LEDs electrically connected in series, identically expressed as $N \times V_{th}<V_N<N \times V_{max}$;

wherein the controller comprises at least a programmable integrated circuit device or an application specific integrated circuit.

73. The lifestyle LED security light according to claim **72**, wherein the LED is a white light LED having the voltage V across each LED complying with an operating constraint of 2.5 volts$<V_{th}<V<V_{max}<$3.5 volts and the working voltage V_N imposed on the LED load is thereby confined in a domain N×2.5 volts$<V_N<$N×3.5 volts.

74. The lifestyle LED security light according to claim **72**, wherein the power supply unit is configured with an AC/DC power converter to convert an AC power into a least one DC power required for operating the LED security light.

75. The lifestyle LED security light according to claim **72**, wherein the power supply unit comprises a battery module to output at least one DC power for operating the lifestyle LED security light.

76. The lifestyle LED security light according to claim **75**, wherein the battery module is a rechargeable battery module.

77. The lifestyle LED security light according to claim **76**, wherein the rechargeable battery module is a solar battery module including a solar panel, a charging circuitry and a rechargeable battery.

* * * * *

EXHIBIT D

US010225902B2

(12) **United States Patent**
Chen

(10) **Patent No.: US 10,225,902 B2**
(45) **Date of Patent: *Mar. 5, 2019**

(54) **TWO-LEVEL SECURITY LIGHT WITH MOTION SENSOR**

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(73) Assignee: **Vaxcel International Co., Ltd.**, Carol Stream, IL (US)

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This patent is subject to a terminal disclaimer.

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(22) Filed: **Feb. 14, 2018**

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H05B 33/08 (2006.01)
(Continued)

(52) **U.S. Cl.**
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(Continued)

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USPC 315/149, 152, 154, 307, 308, 312
See application file for complete search history.

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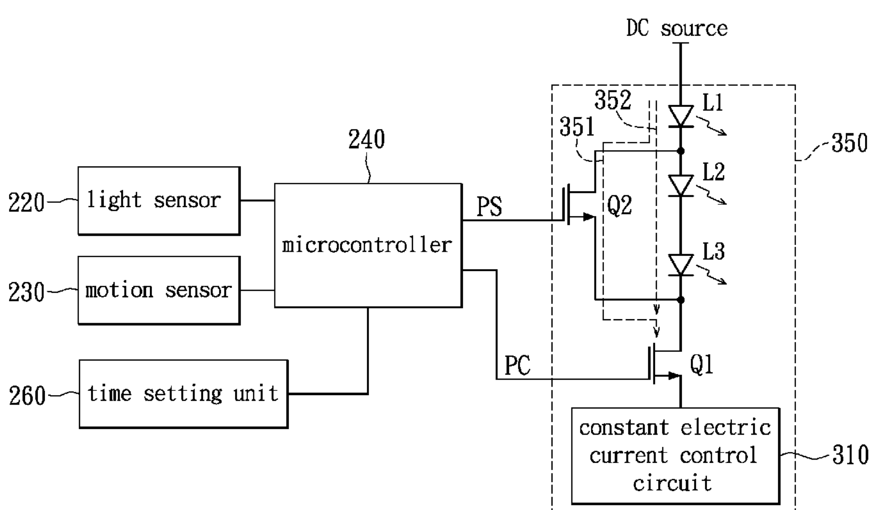
Primary Examiner — Tung X Le
(74) *Attorney, Agent, or Firm* — Rosenberg, Klein & Lee

(57) **ABSTRACT**

A life-style two-level LED security light with a motion sensor. The life-style two-level LED security light includes a light-emitting unit configured with two sets of LEDs respectively emitting different color temperature lights. At night, the light-emitting unit is turned on for a low level illumination with a low color temperature light featuring an ascetic night view. When the motion sensor detects a motion intrusion, the light-emitting unit is switched from the low level illumination with the low color temperature light to a high level illumination with a high color temperature light to perform a dual effect of security alert and to enable an occupant to have a high visibility of the surrounding environment when needed. The low level illumination also creates a light house effect to help an occupant move toward a destination without encountering an accident or getting lost.

34 Claims, 18 Drawing Sheets



Related U.S. Application Data

No. 15/375,777, filed on Dec. 12, 2016, now Pat. No. 9,826,590, which is a continuation of application No. 14/836,000, filed on Aug. 26, 2015, now Pat. No. 9,622,325, which is a division of application No. 14/478,150, filed on Sep. 5, 2014, now Pat. No. 9,445,474, which is a continuation of application No. 13/222,090, filed on Aug. 31, 2011, now Pat. No. 8,866,392.

(51) **Int. Cl.**

G08B 15/00	(2006.01)
H05B 39/04	(2006.01)
F21S 9/03	(2006.01)
F21V 17/02	(2006.01)
G08B 5/36	(2006.01)
G08B 13/189	(2006.01)
H02J 7/35	(2006.01)
F21Y 115/10	(2016.01)
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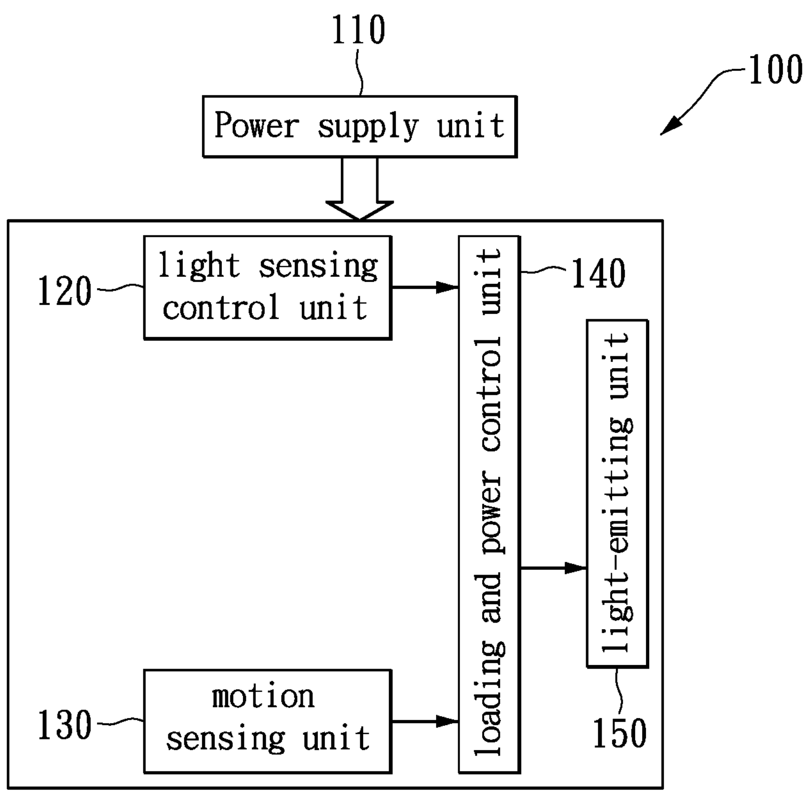
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100
Power supply unit
light sensing control unit
120
loading and power control unit
140
light-emitting unit
motion sensing unit
130
150

FIG. 1

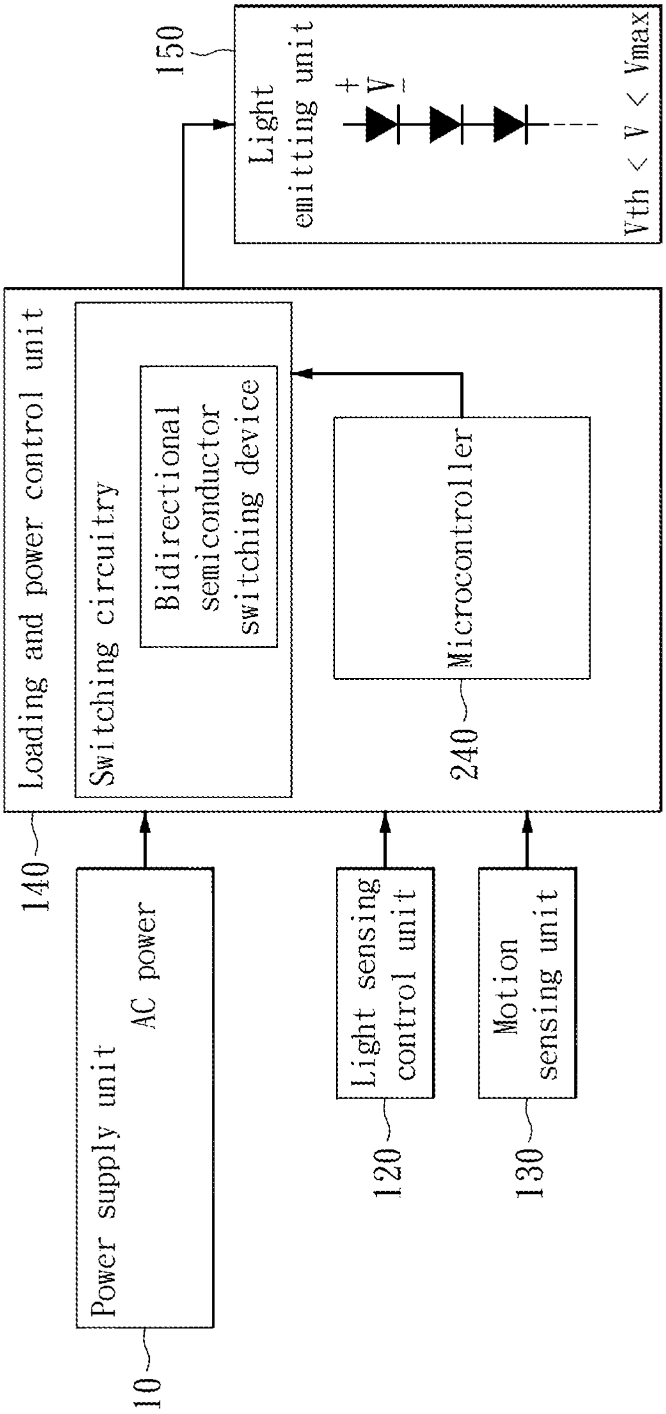

150
Light emitting unit
+ V −
Vth < V < Vmax
Loading and power control unit
Switching circuitry
Bidirectional semiconductor switching device
Microcontroller
240
140
Power supply unit
AC power
110
Light sensing control unit
120
Motion sensing unit
130

FIG. 1A

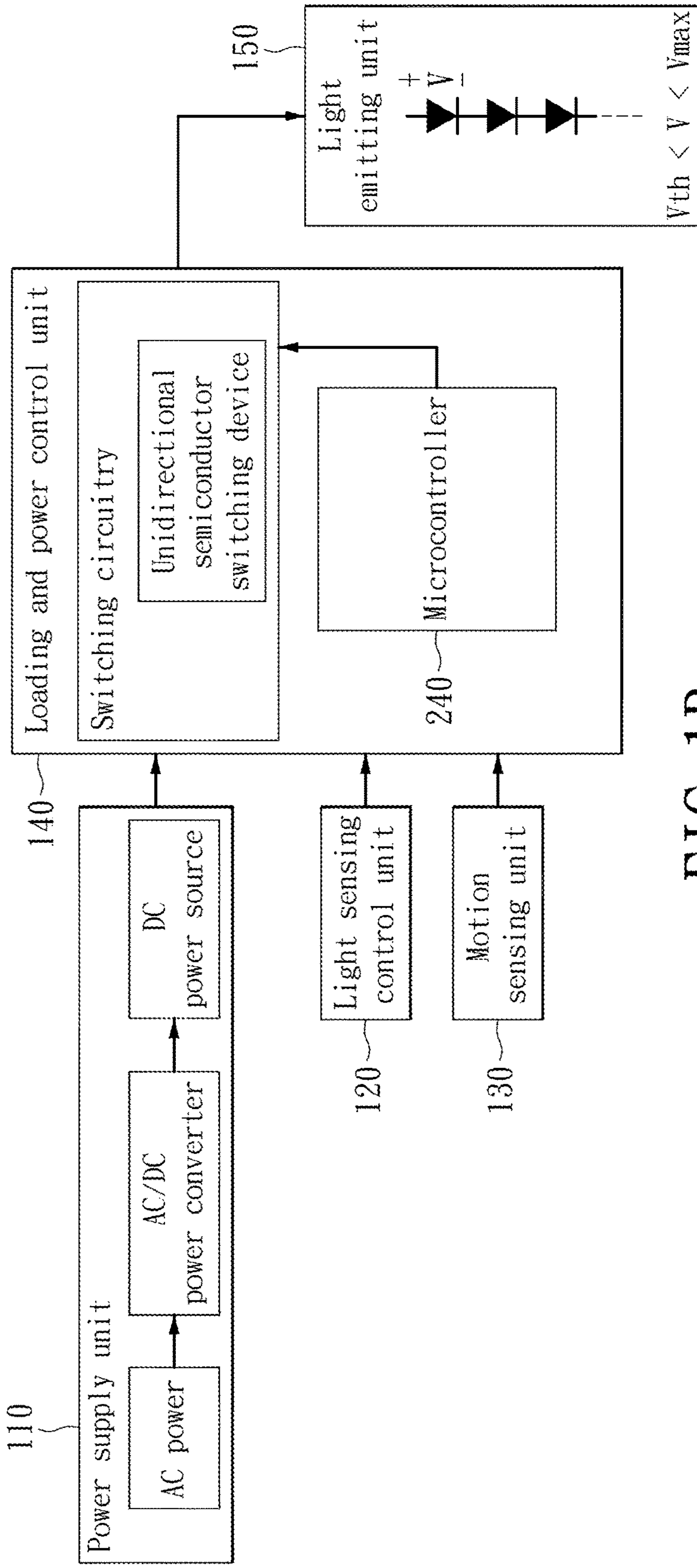

110
Power supply unit
AC power
AC/DC power converter
DC power source
120
Light sensing control unit
130
Motion sensing unit
140
Loading and power control unit
Switching circuitry
Unidirectional semiconductor switching device
Microcontroller
240
150
Light emitting unit
+ V −
Vth < V < Vmax

FIG. 1B

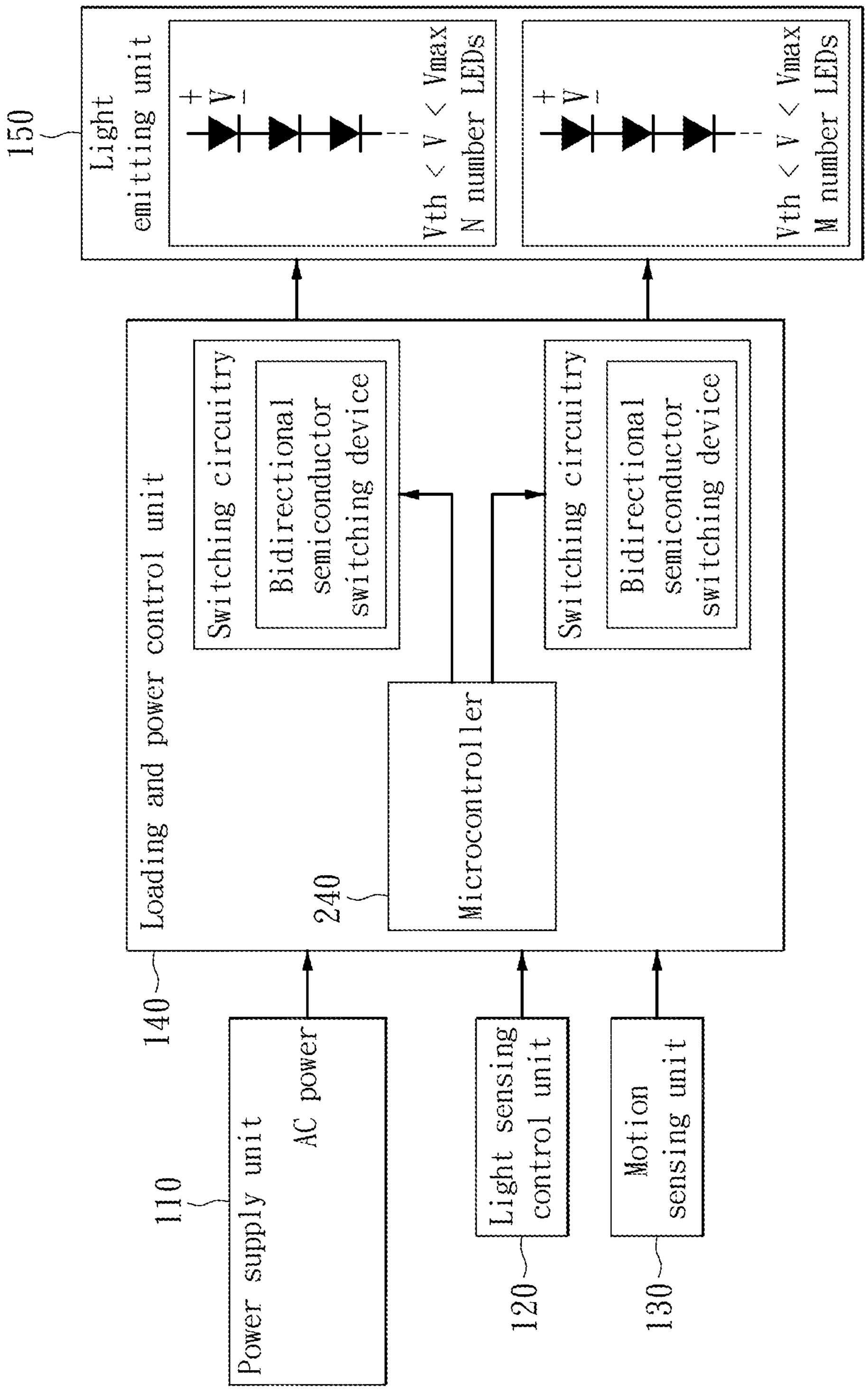

150
Light emitting unit
+ V −
Vth < V < Vmax
N number LEDs
+ V −
Vth < V < Vmax
M number LEDs
140
Loading and power control unit
Switching circuitry
Bidirectional semiconductor switching device
Switching circuitry
Bidirectional semiconductor switching device
240
Microcontroller
110
Power supply unit
AC power
120
Light sensing control unit
130
Motion sensing unit

FIG. 1C

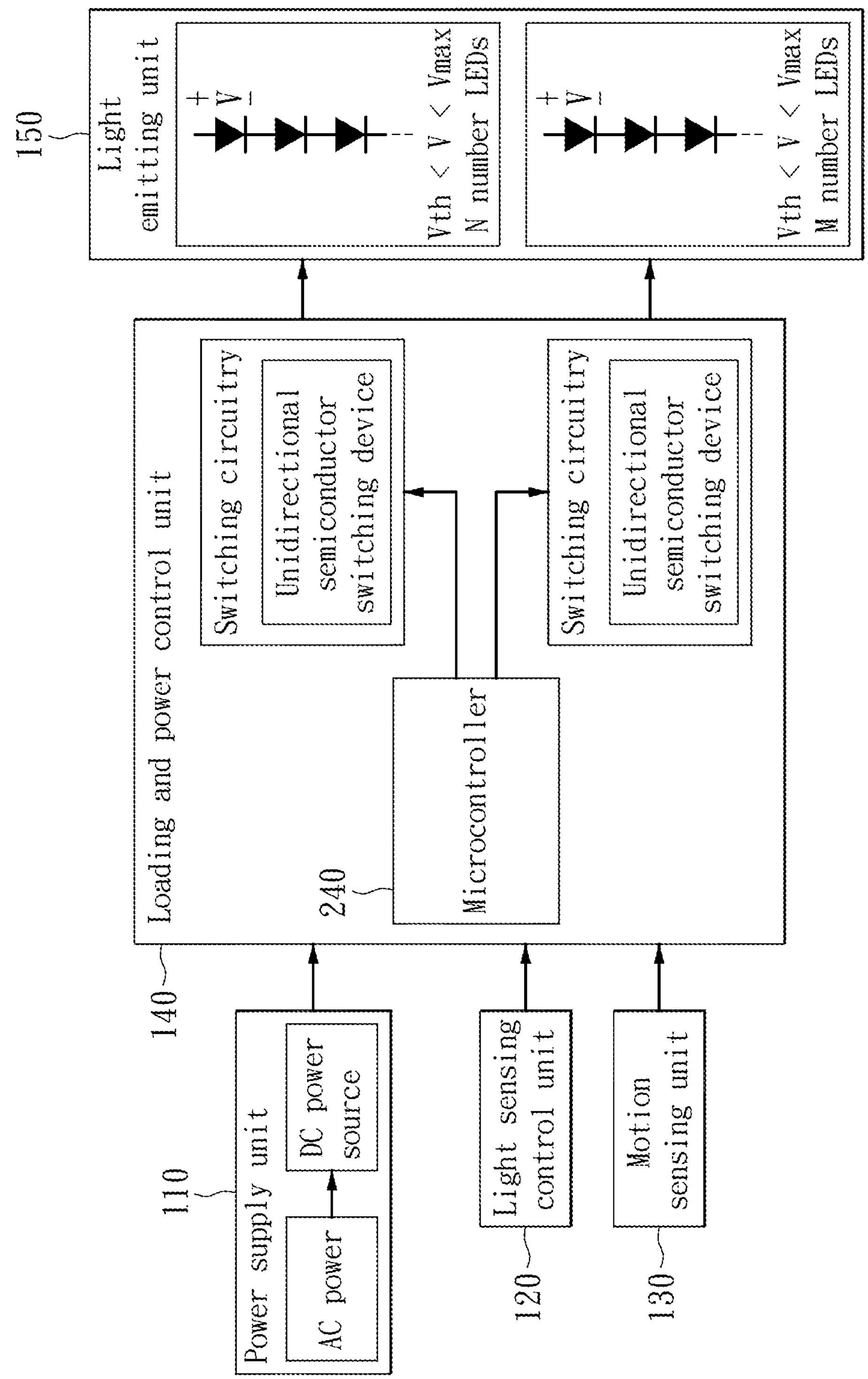

150
Light emitting unit
+ V −
Vth < V < Vmax
N number LEDs
+ V −
Vth < V < Vmax
M number LEDs
Loading and power control unit
Switching circuitry
Unidirectional semiconductor switching device
Switching circuitry
Unidirectional semiconductor switching device
240
Microcontroller
140
110
Power supply unit
AC power
DC power source
Light sensing control unit
120
Motion sensing unit
130

FIG. 1D

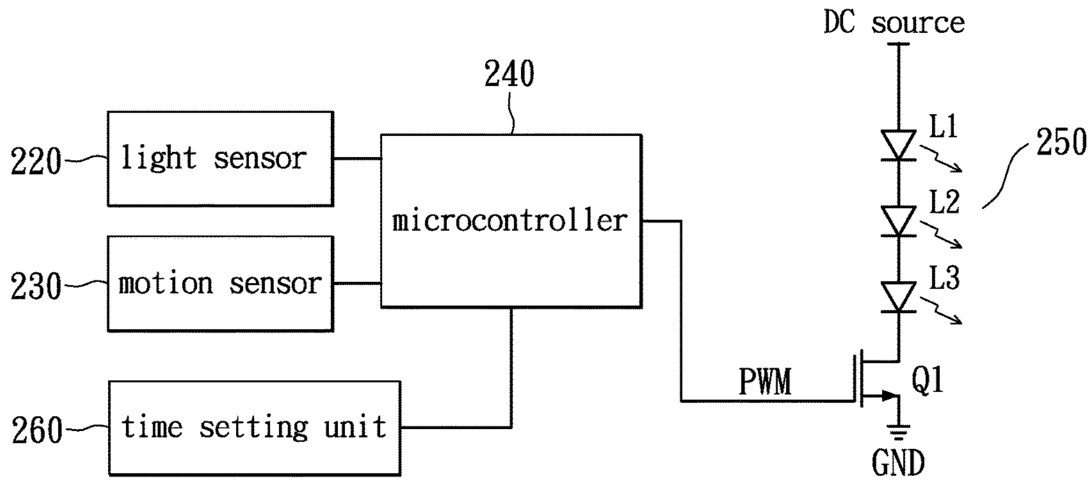

DC source
240
220
light sensor
microcontroller
L1
250
L2
230
motion sensor
L3
PWM
Q1
260
time setting unit
GND

FIG. 2A

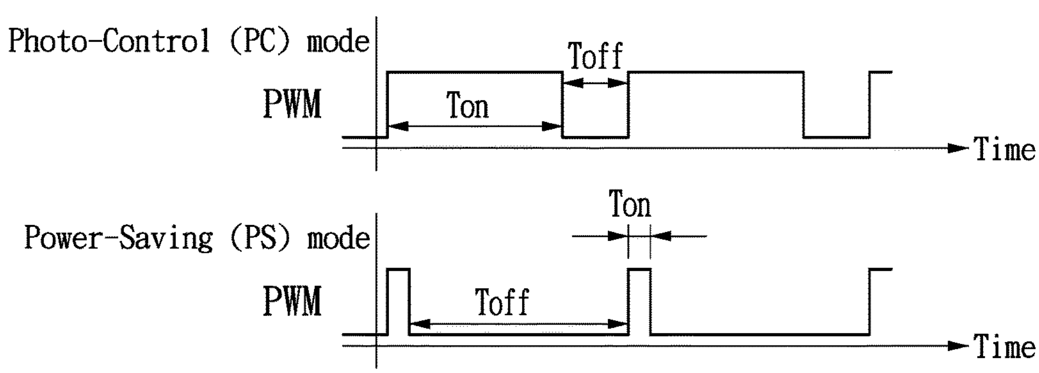
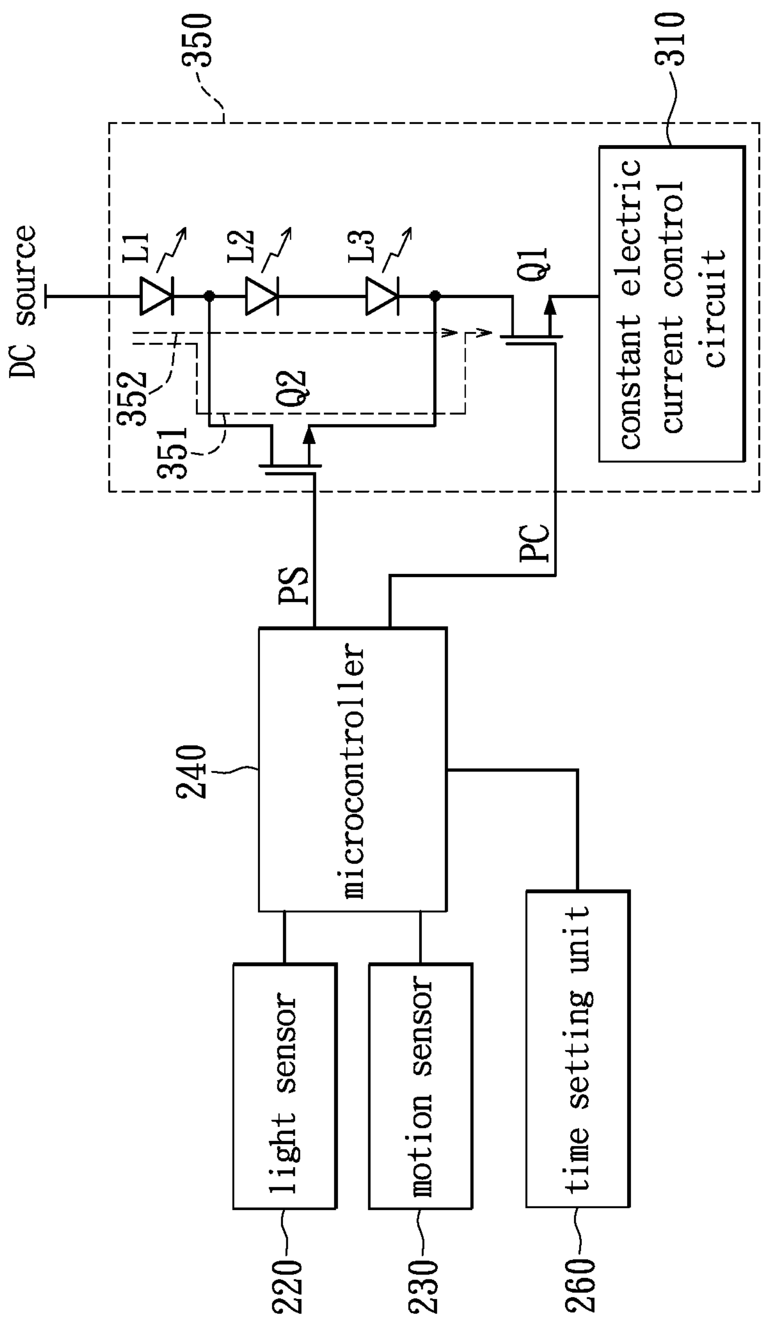


Photo-Control (PC) mode
Toff
PWM
Ton
Time
Ton
Power-Saving (PS) mode
PWM
Toff
Time

FIG. 2B



350
310
DC source
L1
L2
L3
Q1
352
351
Q2
constant electric current control circuit
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 3A

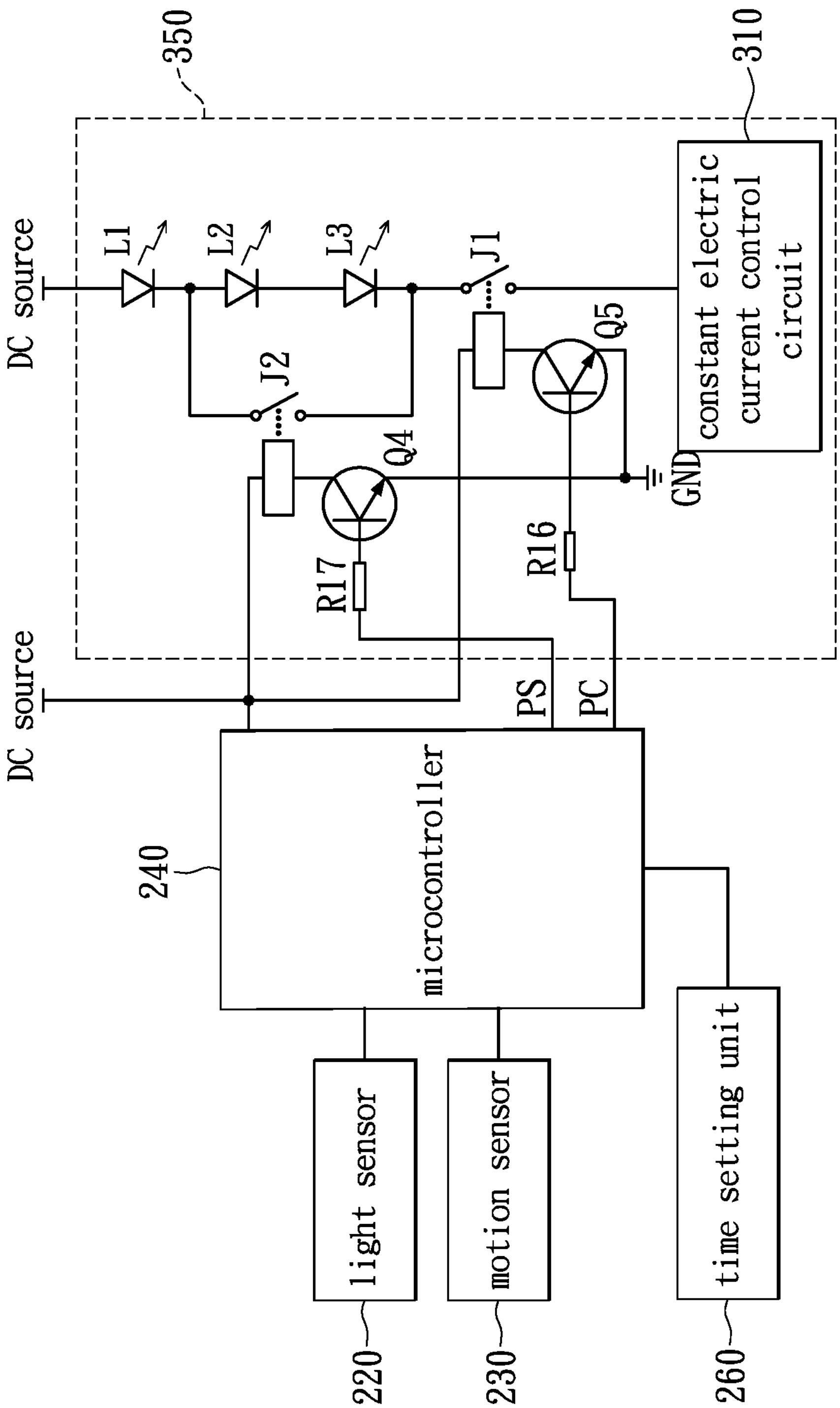

350
310
DC source
L1
L2
L3
J1
J2
Q4
Q5
constant electric current control circuit
GND
R16
R17
DC source
PS
PC
microcontroller
240
light sensor
motion sensor
time setting unit
220
230
260

FIG. 3B

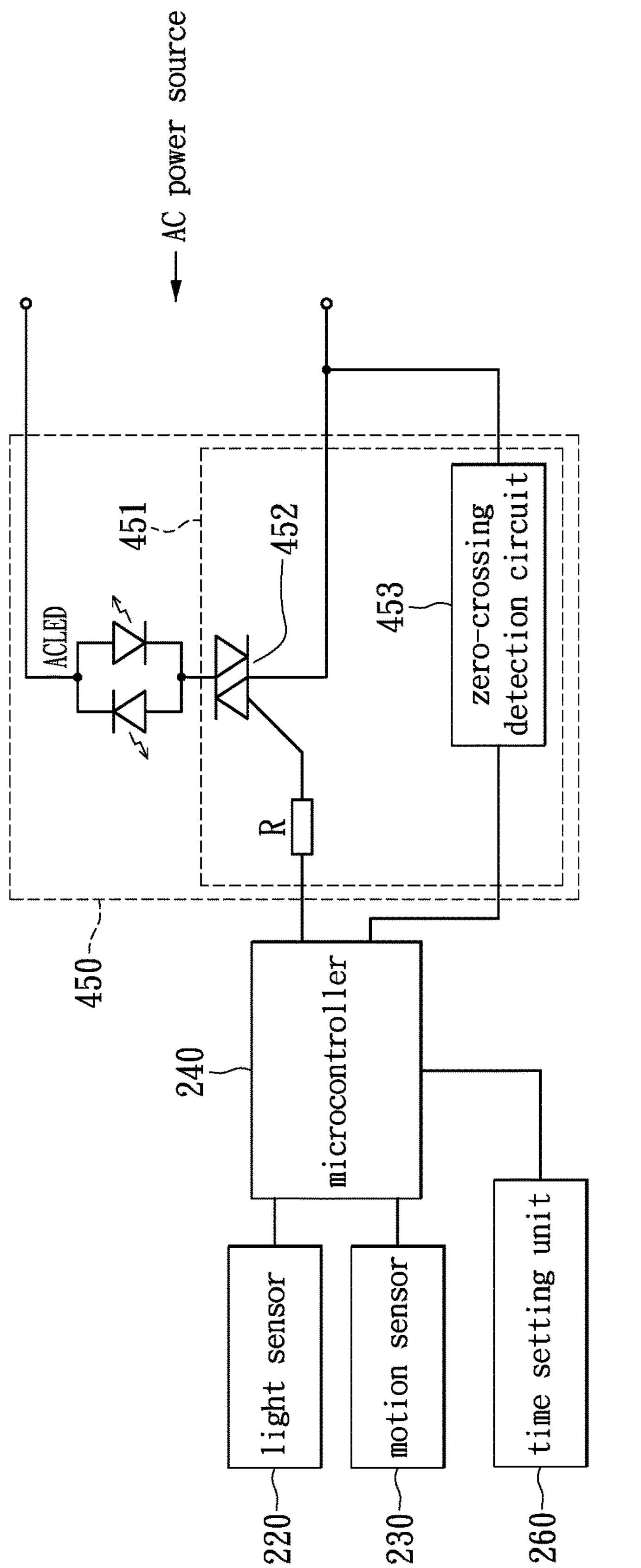

AC power source
ACLED
451
452
453
zero-crossing detection circuit
R
450
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 4A

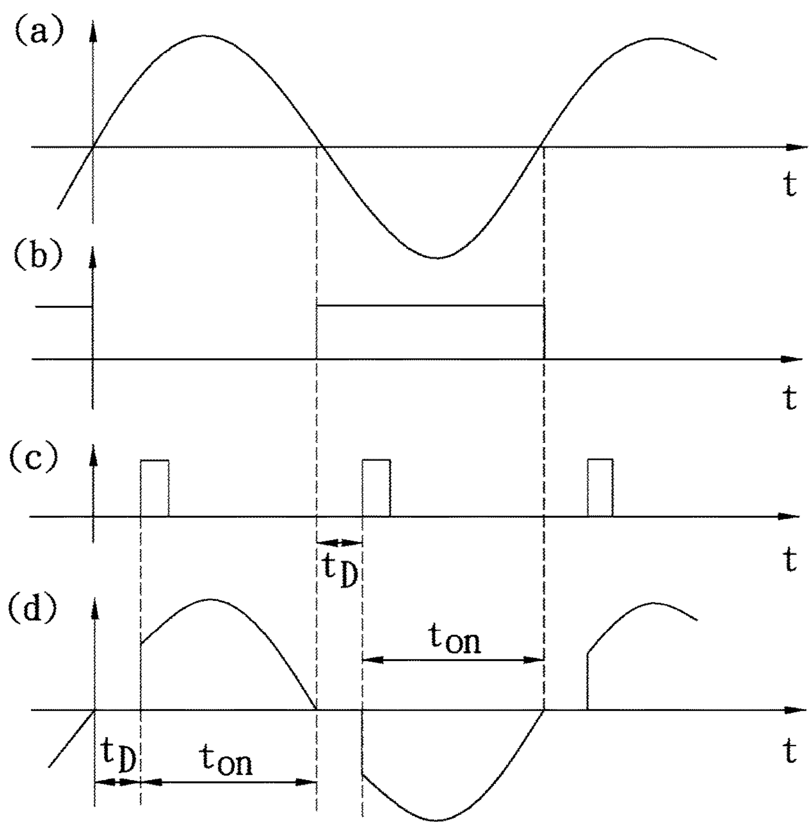


FIG. 4B

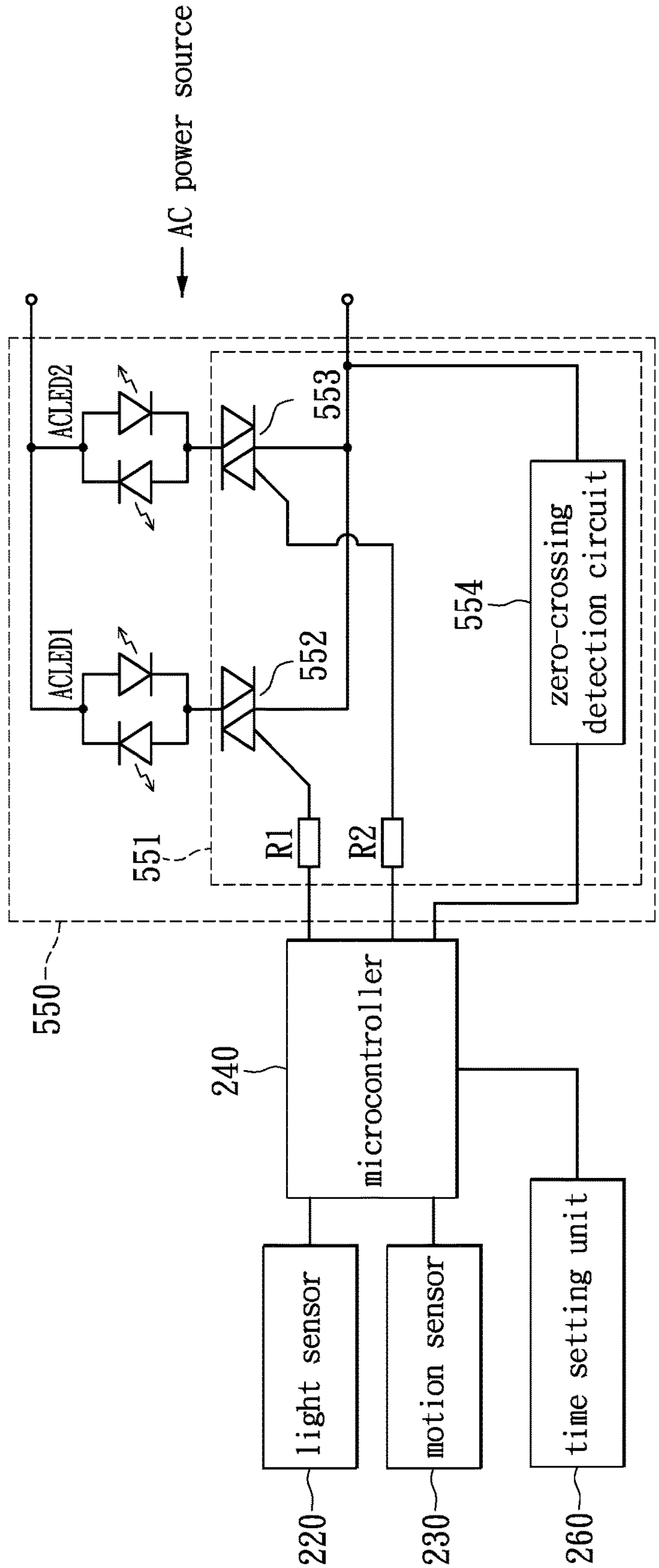

AC power source
ACLED2
ACLED1
553
552
551
R1
R2
554
zero-crossing detection circuit
550
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 5

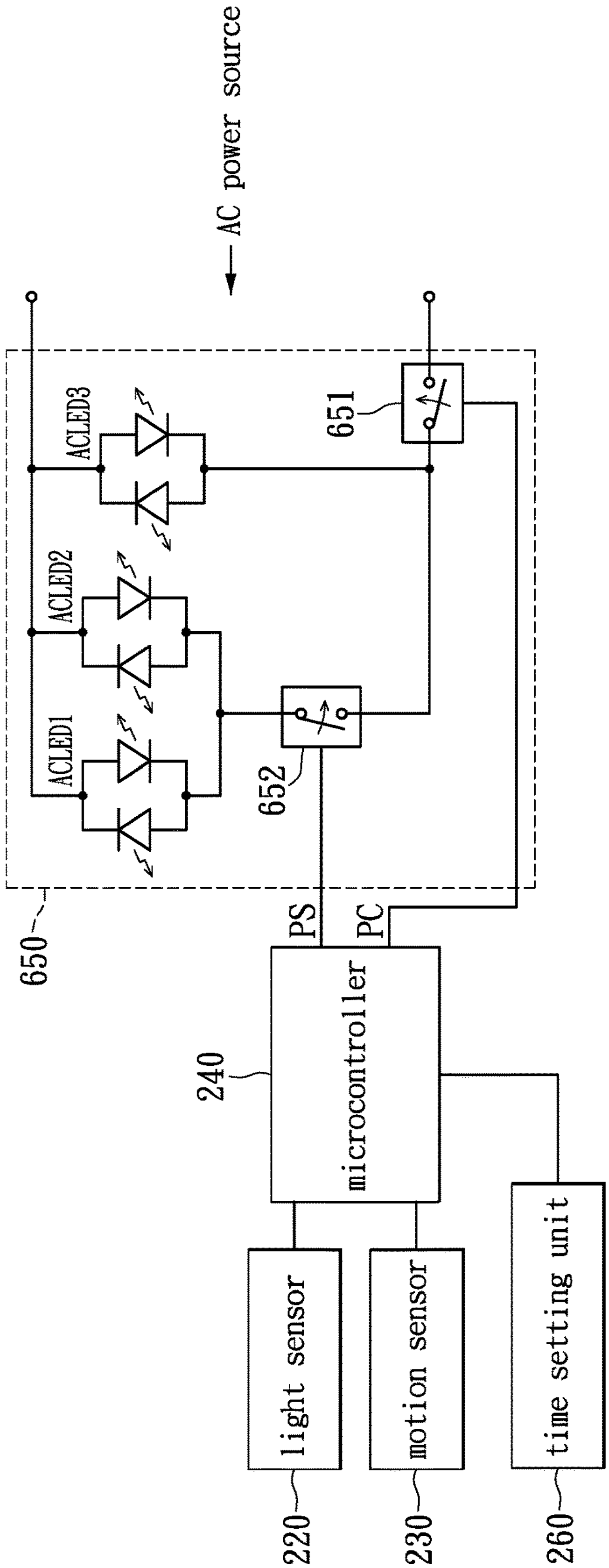

AC power source
ACLED1
ACLED2
ACLED3
651
652
650
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 6

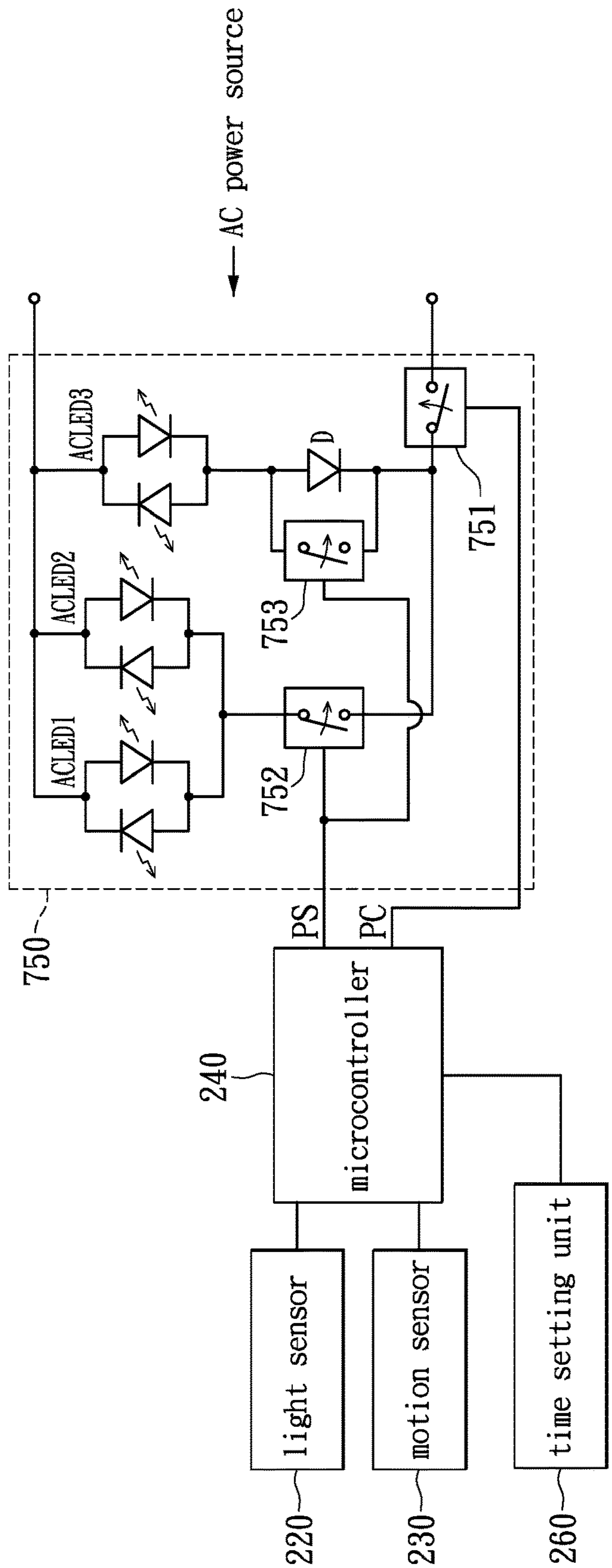

AC power source
ACLED1
ACLED2
ACLED3
D
750
751
752
753
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 7

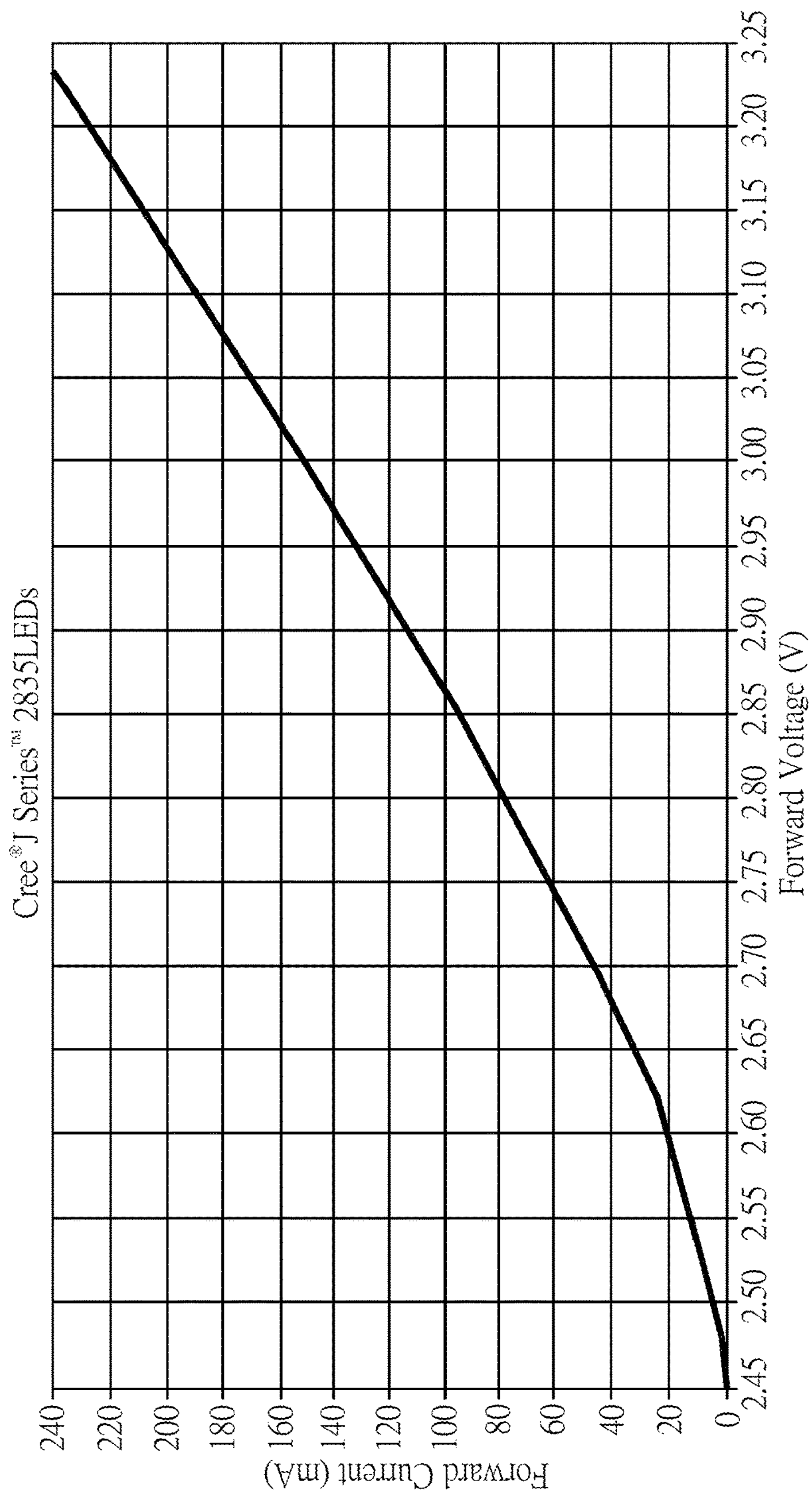

Cree® J Series™ 2835LEDs
Forward Current (mA)
0
20
40
60
80
100
120
140
160
180
200
220
240
Forward Voltage (V)
2.45
2.50
2.55
2.60
2.65
2.70
2.75
2.80
2.85
2.90
2.95
3.00
3.05
3.10
3.15
3.20
3.25

FIG. 8A

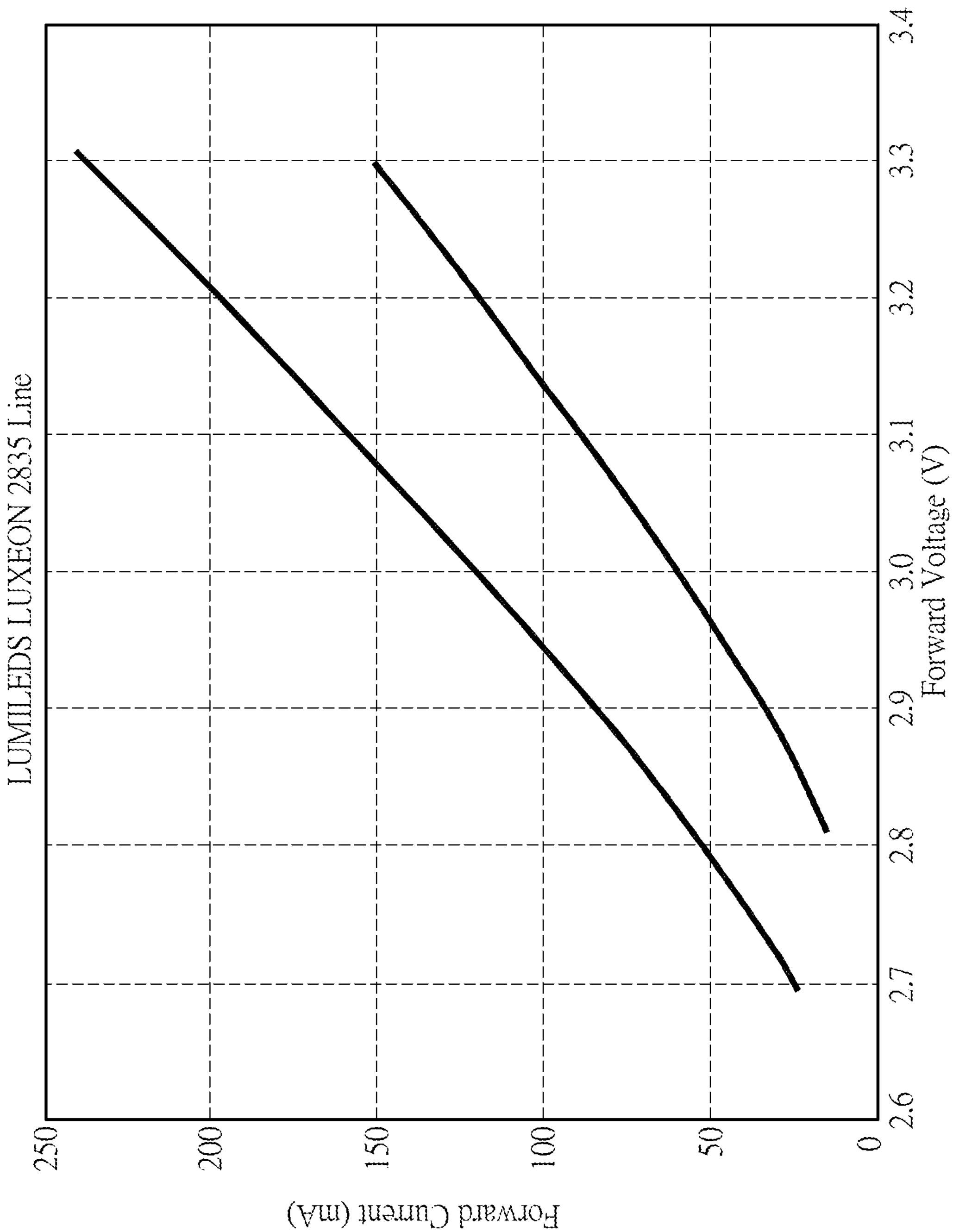

LUMILEDS LUXEON 2835 Line
Forward Current (mA)
250
200
150
100
50
0
Forward Voltage (V)
2.6
2.7
2.8
2.9
3.0
3.1
3.2
3.3
3.4

FIG. 8B

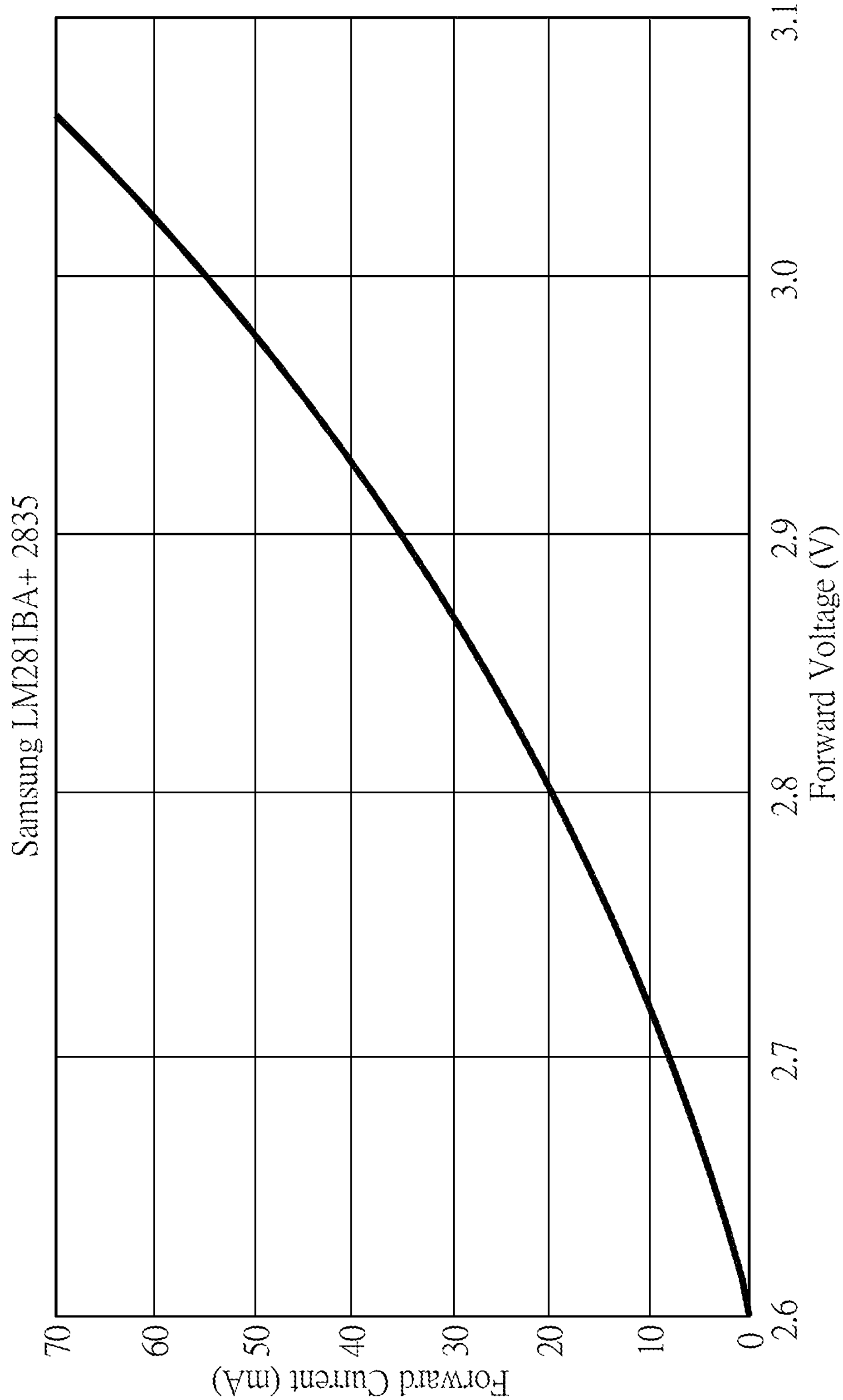

Samsung LM281BA+ 2835
Forward Current (mA)
70
60
50
40
30
20
10
0
Forward Voltage (V)
2.6
2.7
2.8
2.9
3.0
3.1

FIG. 8C

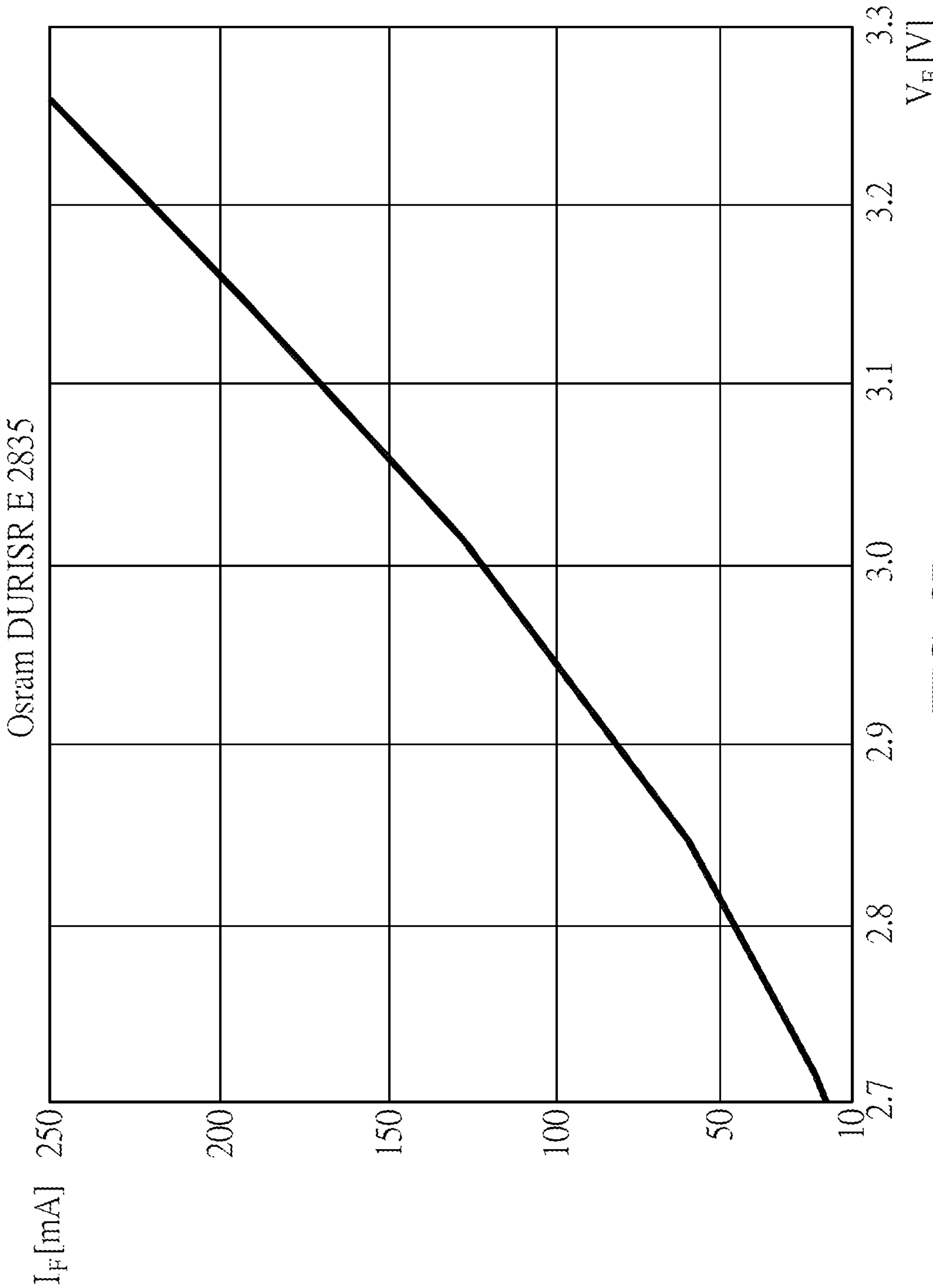

Osram DURISR E 2835
I_F [mA]
250
200
150
100
50
10
2.7
2.8
2.9
3.0
3.1
3.2
3.3
V_F [V]

FIG. 8D

Brand	V_F Min.	V_F Max.	Product Series	Information Source
CREE	2.9V	3.3V	J Series LEDs/J Series 2835	www.cree.com/led-components/products/j2835/jseries-2835
LUMILEDS	2.7V	3.3V	LUXEON 2835 Line	www.lumileds.com/luxeon2835line
SAMSUNG	2.9V	3.3V	KM281BA+	www.samsung.com/app/components/products/j2835/jseries-2835
OSRAM	2.7V	3.3V	DURIS® E/DURISR E 2835	www.osram.com/app/product_selector/#!?query=DORIS%20E%202835&sortField=&sortOrder=&start-0&filters=productbrand,DORIS,E&filters-productbrand,DORIS

FIG. 9

TWO-LEVEL SECURITY LIGHT WITH MOTION SENSOR

CROSS-REFERENCE TO RELATED APPLICATION

This is a continuation application of prior application Ser. No. 15/785,658, filed on Oct. 17, 2017, currently pending. Ser. No. 15/785,658 is a continuation application of U.S. Pat. No. 9,826,590, filed on Dec. 12, 2016. U.S. Pat. No. 9,826,590 is a continuation application of prior application Ser. No. 14/836,000 filed on Aug. 26, 2015, which issued as U.S. Pat. No. 9,622,325, and which is a divisional application of Ser. No. 14/478,150, filed on Sep. 5, 2014, and entitled A TWO-LEVEL LED SECURITY LIGHT WITH MOTION SENSOR, issued as U.S. Pat. No. 9,445,474, which is a continuation application of Ser. No. 13/222,090, filed Aug. 31, 2011, which issued as U.S. Pat. No. 8,866,392 on Oct. 21, 2014.

BACKGROUND OF THE INVENTION

1. Technical Field

The present disclosure relates to a lighting apparatus, in particular, to a two-level security LED light with motion sensor

2. Description of Related Art

Lighting sources such as the fluorescent lamps, the incandescent lamps, the halogen lamps, and the light-emitting diodes (LED) are commonly found in lighting apparatuses for illumination purpose. Photoresistors—are often utilized in outdoor lighting applications for automatic illuminations, known as the Photo-Control (PC) mode. Timers may be used in the PC mode for turning off the illumination or for switching to a lower level illumination of a lighting source after the lighting source having delivered a high level illumination for a predetermined duration, referred as the Power-Saving (PS) mode. Motion sensors are often used in the lighting apparatus for delivering full-power illumination thereof for a short duration when a human motion is detected, then switching back to the PS mode. Illumination operation controls such as auto-illumination in accordance to the background brightness detection, illumination using timer, illumination operation control using motion sensing results (e.g., dark or low luminous power to fully illuminated), and brightness control are often implemented by complex circuitries. In particular, the design and construction of LED drivers are still of a complex technology with high fabrication cost.

Therefore, how to develop a simple and effective design method on illumination controls such as enhancing contrast in illumination and color temperature for various types lighting sources, especially the controls for LEDs are the topics of the present disclosure.

SUMMARY OF THE INVENTION

An exemplary embodiment of the present disclosure provides a two-level LED security light with motion sensor which may switch to high level illumination in the Power-Saving (PS) mode for a predetermined duration time when a human motion is detected thereby achieve warning purpose using method of electric current or lighting load adjustment. Furthermore, prior to the detection of an intru-

sion, the LED security light may be constantly in the low level illumination to save energy.

An exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit further includes one or a plurality of series-connected LEDs; when the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a high level or a low level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit increases the electric current that flows through the light-emitting unit so as to generate the high level illumination for a predetermined duration.

Another exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, a light-emitting unit. The light-emitting unit includes a plurality of series-connected LEDs. When the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on a portion or all the LEDs of the light-emitting unit to generate a low level or a high level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off all the LEDs in the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit turns on a plurality of LEDs in the light-emitting unit and generates the high level illumination for a predetermine duration. An electric current control circuit is integrated in the exemplary embodiment for providing constant electric current to drive the LEDS in the light-emitting unit.

One exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes a phase controller and one or a plurality of parallel-connected alternating current (AC)LEDs. The phase controller is coupled between the described one or a plurality parallel-connected ACLEDs and AC power source. The loading and power control unit may through the phase controller control the average power of the light-emitting unit; when the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a high level or a lower level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit increases the average power of the light-emitting unit thereby generates the high level illumination for a predetermine duration.

According to an exemplary embodiment of the present disclosure, a two-level LED security light includes a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes X high wattage ACLEDs and Y low wattage ACLEDs connected in parallel. When the light sensing control unit detects that the ambient

light is lower than a predetermined value, the loading and power control unit turns on the plurality of low wattage ACLEDs to generate a low level illumination; when the light sensing control unit detects that the ambient light is higher than a predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensor detects an intrusion, the loading and power control unit turns on both the high wattage ACLEDs and the low wattage ACLEDs at same time thereby generates a high level illumination for a predetermine duration, wherein X and Y are of positive integers.

According to an exemplary embodiment of the present disclosure, a two-level LED security light with motion sensor includes a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes a rectifier circuit connected between one or a plurality of parallel-connected AC lighting sources and AC power source. The loading and power control unit may through the rectifier circuit adjust the average power of the light-emitting unit. When the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a low level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects an intrusion, the loading and power control unit increases the average power of the light-emitting unit thereby generates a high level illumination for a predetermine duration. The rectifier circuit includes a switch parallel-connected with a diode, wherein the switch is controlled by the loading and power control unit.

To sum up, a two-level LED security light with motion sensor provided by an exemplary embodiment in the preset disclosure, may execute Photo-Control (PC) and Power-Saving (PS) modes. When operates in the PC mode, the lighting apparatus may auto-illuminate at night and auto-turnoff at dawn. The PC mode may generate a high level illumination for a predetermined duration then automatically switch to the PS mode by a control unit to generate a low level illumination. When the motion sensor detects a human motion, the disclosed LED security light may immediate switch to the high level illumination for a short predetermined duration thereby achieve illumination or warning effect. After the short predetermined duration, the LED security light may automatically return to the low level illumination for saving energy.

In order to further understand the techniques, means and effects of the present disclosure, the following detailed descriptions and appended drawings are hereby referred, such that, through which, the purposes, features and aspects of the present disclosure can be thoroughly and concretely appreciated; however, the appended drawings are merely provided for reference and illustration, without any intention to be used for limiting the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the present disclosure, and are incorporated in and constitute a part of this specification. The drawings illustrate exemplary embodiments of the present disclosure and, together with the description, serve to explain the principles of the present disclosure.

FIG. **1** schematically illustrates a block diagram of a two-level LED security light in accordance with an exemplary embodiment of the present disclosure.

FIG. **1**A is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for an AC LED two-level security light, wherein the loading and power comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises a bidirectional semiconductor switching device for controlling an average electric power to be delivered to the AC LED.

FIG. **1**B is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for a DC LED two-level security light, wherein the loading and power control unit comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises an unidirectional semiconductor switching device for controlling an average electric power to be delivered to the DC LED.

FIG. **1**C is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for a AC LED two-level security light including a first set having N number LEDs and a second set having M number LEDs, wherein the loading and power control unit comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises bidirectional semiconductor switching devices for controlling an average electric power to be delivered to the AC LED.

FIG. **1**D is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for a DC LED two-level security light including a first set having N number LEDs and a second set having M number LEDs, wherein the loading and power control unit comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises unidirectional semiconductor switching devices for controlling an average electric power to be delivered to the DC LED.

FIG. **2**A illustrates a schematic diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure.

FIG. **2**B graphically illustrates a timing waveform of a pulse width modulation (PWM) signal in accordance to the first exemplary embodiment of the present disclosure.

FIG. **3**A illustrates a schematic diagram of a two-level LED security light in accordance to the second exemplary embodiment of the present disclosure.

FIG. **3**B illustrates a schematic diagram of a two-level LED security light in accordance to the second exemplary embodiment of the present disclosure.

FIG. **4**A illustrates a schematic diagram of a two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **4**B illustrates a timing waveform of two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **5** illustrates a schematic diagram of a two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **6** illustrates a schematic diagram of a two-level LED security light in accordance to the fourth exemplary embodiment of the present disclosure.

FIG. **7** illustrates a schematic diagram of a two-level LED security light in accordance to the fifth exemplary embodiment of the present disclosure.

FIGS. **8**A, **8**B, **8**C and **8**D schematically and respectively show I-V relationship charts (Forward Current vs. Forward Voltage) for a white LED chip from each of 4 different LED manufacturers.

FIG. **9** is a data sheet showing data of the minimum forward voltages and maximum forward voltages collected from various LED manufacturers.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Reference is made in detail to the exemplary embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or alike parts.

First Exemplary Embodiment

Refer to FIG. **1**, which schematically illustrates a block diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure. A two-level LED security light (herein as the lighting apparatus)**100** includes a power supply unit **110**, a light sensing control unit **120**, a motion sensing unit **130**, a loading and power control unit **140**, and a light-emitting unit **150**. The power supply unit **110** is used for supplying power required to operate the system, wherein the associated structure includes the known AC/DC voltage converter. The light sensing control unit **120** may be a photoresistor, which may be coupled to the loading and power control unit **140** for determining daytime or nighttime in accordance to the ambient light. The motion sensing unit **130** may be a passive infrared sensor (PIR), which is coupled to the loading and power control unit **140** and is used to detect intrusions. When a person is entering a predetermined detection zone of the motion sensing unit **130**, a sensing signal thereof may be transmitted to the loading and power control unit **140**.

The loading and power control unit **140** which is coupled to the light-emitting unit **150** may be implemented by a microcontroller. The loading and power control unit **140** may control the illumination levels of the light-emitting unit **150** in accordance to the sensing signal outputted by the light sensing control unit **120** and the motion sensing unit **130**. The light-emitting unit **150** may include a plurality of LEDs and switching components. The loading and power control unit **140** may control the light-emitting unit **150** to generate at least two levels of illumination variations.

When the light sensing control unit **120** detects that the ambient light is lower than a predetermined value (i.e., nighttime), the loading and power control unit **140** executes the Photo-Control (PC) mode by turning on the light-emitting unit **150** to generate a high level illumination for a predetermined duration then return to a low level illumination for Power-Saving (PS) mode. When the light sensing control unit **120** detects that the ambient light is higher than a predetermined value (i.e., dawn), the loading and power control unit **140** turns off the light-emitting unit **150**. In the PS mode, when the motion sensing unit **130** detects a human motion, the loading and power control unit **140** may increase the electric current which flow through the light-emitting unit **150**, to generate the high level illumination for a short predetermined duration. After the short predetermined duration, the loading and power control unit **140** may automatically lower the electric current that flow through the light-emitting unit **150** thus have the light-emitting unit **150** return to low level illumination for saving energy.

Refer to **2**A, which illustrates a schematic diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure. The light sensing control unit **120** may be implemented by a light sensor **220**; the motion sensing unit **130** may be implemented by a motion sensor **230**; the loading and power control unit **140** may be implemented by a microcontroller **240**. The light-emitting unit **250** includes three series-connected LEDs L**1**~L**3**. The LEDs L**1**~L**3** is connected between a DC source and a transistor Q**1**, wherein the DC source may be provided by the power supply unit **110**. The transistor Q**1** may be an N-channel metal-oxide-semiconductor field-effect-transistor (NMOS). The transistor Q**1** is connected between the three series-connected LEDs L**1**~L**3** and a ground GND. The loading and power control unit **140** implemented by the microcontroller **240** may output a pulse width modulation (PWM) signal to the gate of transistor Q**1** to control the average electric current. It is worth to note that the electric components depicted in FIG. **2**A only serves as an illustration for the exemplary embodiment of the present disclose and hence the present disclosure is not limited thereto.

Refer to FIG. **2**B concurrently, which graphically illustrates a timing waveform of a pulse width modulation (PWM) signal in accordance to the first exemplary embodiment of the present disclosure. In the PC mode, the PWM signal may be used to configure the transistor Q**1** to have the conduction period T_{off} being longer than the cut-off period T_{off}. On the other hand in the PS mode, the PWM signal may configure the transistor Q**1** to have the conduction period T_{on} being shorter than the cut-off period T_{off}. In comparison of the illumination levels between the PC and PS modes, as the conduction period T_{on} of transistor Q**1** being longer under the PC mode, therefore have higher average electric current driving the light-emitting unit **250** thereby generate high illumination, which may be classified as the high level illumination; whereas as the conduction period T_{on} of transistor Q**1** is shorter in the PS mode, therefore have lower average electric current driving the light-emitting unit **250** thereby generate low illumination, which may be classified as the low level illumination.

The microcontroller **240** turns off the light-emitting unit **250** during the day and activates the PC mode at night by turning on the light-emitting unit **250** to generate the high level illumination for a short predetermined duration then return to the low level illumination thereby entering the PS mode. When the motion sensor **230** detects a human motion in the PS mode, the light-emitting unit **250** may switch to the high level illumination for illumination or warning application. The light-emitting unit **250** may return to the low level illumination after maintaining at the high level illumination for a short predetermined duration to save energy.

In addition, the microcontroller **240** is coupled to a time setting unit **260**, wherein the time setting unit **260** may allow the user to configure the predetermined duration associated with the high level illumination in the PC mode, however the present disclosure is not limited thereto.

Second Exemplary Embodiment

Refer again to FIG. **1**, wherein the illumination variations of the light-emitting unit **150** may be implemented through the number of light-source loads being turned on to generate more than two levels of illumination. The lighting apparatus **100** in the instant exemplary embodiment may be through turning on a portion of LEDs or all the LEDs to generate a low and a high level of illuminations.

Refer to FIG. **3**A concurrently, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the second exemplary embodiment of the present disclosure. The main difference between FIG. **3**A

and FIG. **2**A is in the light-emitting unit **350**, having three series-connected LEDs L**1**~L**3** and NMOS transistors Q**1** and Q**2**. The LEDs L**1**~L**3** are series connected to the transistor Q**1** at same time connected between the DC source and a constant electric current control circuit **310**. Moreover, transistor Q**2** is parallel connected to the two ends associated with LEDs L**2** and L**3**. The gates of the transistors Q**1** and Q**2** are connected respectively to a pin PC and a pin PS of the microcontroller **240**. The constant electric current control circuit **310** in the instant exemplary embodiment maintains the electric current in the activated LED at a constant value, namely, the LEDs L**1**~L**3** are operated in constant-current mode.

Refer to FIG. **3**A, the pin PC of the microcontroller **240** controls the switching operations of the transistor Q**1**; when the voltage level of pin PC being either a high voltage or a low voltage, the transistor Q**1** may conduct or cut-off, respectively, to turn the LEDs L**1**~L**3** on or off. The pin PS of the microcontroller **240** controls the switch operations of the transistor Q**2**, to form two current paths **351** and **352** on the light-emitting unit **350**. When the voltage at the pin PS of the microcontroller **240** is high, the transistor Q**2** conducts, thereby forming the current path **351** passing through the LED L**1** and the transistor Q**2**; when the voltage at the pin PS being low, the transistor Q**2** cuts-off, thereby forming the current path **352** passing through all the LEDs L**1**~L**3**. The microcontroller **240** may then control the switching operation of the transistor Q**2** to turn on the desired number of LEDs so as to generate a high or a low level illumination.

When light sensor **220** detects that the ambient light is higher than a predetermined value, the microcontroller **240** through the pin PC outputs a low voltage, which causes the transistor Q**1** to cut-off and turns off all the LEDs L**1**~L**3** in the light-emitting unit **350**. Conversely, when the light sensor **220** detects that the ambient light is lower than the predetermined value, the microcontroller **240** activates the PC mode, i.e., outputting a high voltage from pin PC and a low voltage from pin PS, to activate the transistor Q**1** while cut-off the transistor Q**2**, thereby forming the current path **352**, to turn on the three LEDs L**1**~L**3** in the light-emitting unit **350** so as to generate the high level illumination for a predetermined duration. After the predetermined duration, the microcontroller **240** may switch to the PS mode by having the pin PC continue outputting a high voltage and the pin PS outputting a high voltage, to have the transistor Q**2** conducts, thereby forming the current path **351**. Consequently, only the LED L**1** is turned on and the low level illumination is generated.

When the motion sensor detects a human motion in the PS mode, the pin PS of the microcontroller **240** temporarily switches from the high voltage to a low voltage, to have the transistor Q**2** temporarily cuts-off thus forming the current path **352** to activate all the LEDs in the light-emitting unit **350**, thereby temporarily generates the high level illumination. The light-emitting unit **350** is driven by a constant electric current, therefore the illumination level generated thereof is directly proportional to the number of LEDs activated. FIG. **3**B illustrates another implementation for FIG. **3**A, wherein the relays J**1** and J**2** are used in place of NMOS transistors to serve as switches. The microcontroller **240** may control the relays J**2** and J**1** through regulating the switching operations of the NPN bipolar junction transistors Q**4** and Q**5**. Moreover, resistors R**16** and R**17** are current-limiting resistors.

In the PC mode, the relay J**1** being pull-in while the relay J**2** bounce off to have constant electric current driving all the LEDs L**1**~L**3** to generate the high level illumination; in PS mode, the relays J**1** and J**2** both pull-in to have constant electric current only driving the LED L**1** thus the low level illumination may be thereby generated. Furthermore, when the motion sensor **230** detects a human motion, the pin PS of the microcontroller **240** may temporarily switch from high voltage to low voltage, forcing the relay J**2** to temporarily bounce off and the relay J**1** pull-in so as to temporarily generate the high level illumination.

The LED L**1** may adopt a LED having color temperature of 2700K while the LEDs L**2** and L**3** may adopt LEDs having color temperature of 5000K in order to increase the contrast between the high level and the low level illuminations. The number of LEDs included in the light-emitting unit **350** may be more than three, for example five or six LEDs. The transistor Q**2** may be relatively parallel to the two ends associated with a plurality of LEDs to adjust the illumination difference between the high and the low illumination levels. Additionally, the light-emitting unit **350** may include a plurality of transistors Q**2**, which are respectively coupled to the two ends associated with each LED to provide more lighting variation selections. The microcontroller **240** may decide the number of LEDs to turn on in accordance to design needs at different conditions. Based on the explanation of the aforementioned exemplary embodiment, those skills in the art should be able to deduce other implementation and further descriptions are therefore omitted.

Third Exemplary Embodiment

Refer back to FIG. **1**, wherein the light-emitting unit **150** may include a phase controller and one or more parallel-connected alternating current (AC) LEDs. The phase controller is coupled between the described one or more parallel-connected ACLEDs and AC power source. The loading and power controller **140** in the instant exemplary embodiment may through the phase controller adjust the average power of the light-emitting unit **150** so as to generate variations in the low level and the high level illuminations.

Refer to FIG. **4**A, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the third exemplary embodiment of the present disclosure. The main difference between FIG. **4**A and FIG. **3** is in that the light-source load is an ACLED, which is coupled to the AC power source, and further the light-emitting unit **450** includes a phase controller **451**. The phase controller **451** includes a bi-directional switching device **452**, here, a triac, a zero-crossing detection circuit **453**, and a resistor R. The microcontroller **240** turns off the light-emitting unit **450** when the light sensor **220** detects that the ambient light is higher than a predetermined value. Conversely, when the light sensor **220** detects that the ambient light is lower than the predetermined value, the microcontroller **240** activates the PC mode by turning on the light-emitting unit **450**. In the PC mode, the microcontroller **240** may select a control pin for outputting a pulse signal which through a resistor R triggers the triac **452** to have a large conduction angle. The large conduction angle configures the light-emitting unit **450** to generate a high level illumination for a predetermined duration. Then the microcontroller **240** outputs the pulse signal for PS mode through the same control pin to trigger the triac **452** to have a small conduction angle for switching the light-emitting unit **450** from the high level illumination to the low level illumination of the PS mode. Moreover, when the motion sensor **230** (also called motion sensing unit) detects a human motion in the PS mode, the microcontroller **240** temporarily outputs the PC-mode pulse signal

through the same control pin to have the light-emitting unit **450** generated the high level illumination for a short predetermined duration. After the short predetermined duration, the light-emitting unit **450** returns to the low level illumination.

In the illumination control of the ACLED, the microcontroller **240** may utilize the detected zero-crossing time (e.g., the zero-crossing time of an AC voltage waveform) outputted from the zero-crossing detection circuit **453** to send an AC synchronized pulse signal thereof which may trigger the triac **452** of the phase controller **451** thereby to change the average power input to the light-emitting unit **450**. As the ACLED has a cut-in voltage V_t for start conducting, thus if the pulse signal inaccurately in time triggers the conduction of the triac **452**, then the instantaneous value of AC voltage may be lower than the cut-in voltage V_t of ACLED at the trigger pulse. Consequently, the ACLED may result in the phenomenon of either flashing or not turning on. Therefore, the pulse signal generated by the microcontroller **240** must fall in a proper time gap behind the zero-crossing point associated with the AC sinusoidal voltage waveform.

Supposing an AC power source having a voltage amplitude V_m and frequency f, then the zero-crossing time gap t_D of the trigger pulse outputted by the microcontroller **240** should be limited according to $t_o<t_D<\frac{1}{2f}-t_o$ for a light-source load with a cut-in voltage V_t, wherein $t_o=(\frac{1}{2\pi f})\sin^{-1}(V_t/V_m)$. The described criterion is applicable to all types of ACLEDs to assure that the triac **452** can be stably triggered in both positive and negative half cycle of the AC power source. Take ACLED with V_t (rms)=80V as an example, and supposing the V_m(rms)=110V and f=60 Hz, then t_o=2.2 ms and (½ f)=8.3 ms may be obtained. Consequently, the proper zero-crossing time gap t_D associated with the phase modulation pulse outputted by the microcontroller **240** which lagged the AC sinusoidal voltage waveform should be designed in the range of 2.2 ms<t_D<6.1 ms.

Refer to FIG. **4**B, which illustrates a timing waveform of the two-level LED security light in accordance to the third exemplary embodiment of the present disclosure. Waveforms (a)~(d) of FIG. **4**B respectively represent the AC power source, the output of the zero-crossing detection circuit **453**, the zero-crossing delay pulse at the control pin of the microcontroller **240**, and the voltage waveform across the two ends of the ACLED in the light-emitting unit **450**. The zero-crossing detection circuit **453** converts the AC voltage sinusoidal waveform associated with the AC power source to a symmetric square waveform having a low and a high voltage levels as shown in FIG. **4**B(*b*). At the zero-crossing point of the AC voltage sinusoidal wave, the symmetric square waveform may transit either from the low voltage level to the high voltage level or from the high voltage level to the low voltage level. Or equivalently, the edge of the symmetric square waveform in the time domain corresponds to the zero-crossing point of the AC voltage sinusoidal waveform. As shown in FIG. **4**B(*c*), the microcontroller **240** outputs a zero-crossing delay pulse in correspondence to the zero-crossing point of the AC sinusoidal waveform in accordance to the output waveform of the zero-crossing detection circuit **453**. The zero-crossing delay pulse is relative to an edge of symmetric square waveform behind a time gap t_D in the time domain. The t_D should fall in a valid range, as described previously, to assure that the triac **452** can be stably triggered thereby to turn on the ACLED. FIG. **4**B(*d*) illustrates a voltage waveform applied across the two ends associated with the ACLED. The illumination level of the light-emitting unit **450** is related to the conduction period t_{on} of the ACLED, or equivalently, the length t_{on} is directly proportional to the average power inputted to the ACLED. The difference between the PC mode and the PS mode being that in the PC mode, the ACLED has longer conduction period, thereby generates the high level illumination; whereas in the PS mode, the ACLED conduction period is shorter, hence generates the low level illumination.

Refer to FIG. **5**, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the third exemplary embodiment of the present disclosure. The light-emitting unit **550** of the lighting apparatus **100** includes an ACLED**1**, an ACLED**2**, and a phase controller **551**. The phase controller **551** includes triacs **552** and **553**, the zero-crossing detection circuit **554** as well as resistors R**1** and R**2**. The light-emitting unit **550** of FIG. **5** is different from the light-emitting unit **450** of FIG. **4** in that the light-emitting unit **550** has more than one ACLEDs and more than one bi-directional switching devices. Furthermore, the color temperatures of the ACLED**1** and the ACLED**2** may be selected to be different.

In the exemplary embodiment of FIG. **5**, the ACLED**1** has a high color temperature, and the ACLED**2** has a low color temperature. In the PC mode, the microcontroller **240** uses the phase controller **551** to trigger both ACLED**1** and ACLED**2** to conduct for a long period, thereby to generate the high level illumination as well as illumination of mix color temperature. In the PS mode, the microcontroller **240** uses the phase controller **551** to trigger only the ACLED**2** to conduct for a short period, thereby generates the low level illumination as well as illumination of low color temperature. Moreover, in the PS mode, when the motion sensor **230** detects a human motion, the microcontroller **240** may through the phase controller **551** trigger the ACLED**1** and ACLED**2** to conduct for a long period. Thereby, it may render the light-emitting unit **450** to generate the high level illumination of high color temperature and to produce high contrast in illumination and hue, for a short predetermined duration to warn the intruder. Consequently, the lighting apparatus may generate the high level or the low level illumination of different hue. The rest of operation theories associated with the light-emitting unit **550** are essentially the same as the light-emitting unit **450** and further descriptions are therefore omitted.

Fourth Exemplary Embodiment

Refer to FIG. **6**, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the fourth exemplary embodiment of the present disclosure. The light-emitting unit **150** of FIG. **1** may be implemented by the light-emitting unit **650**, wherein the light-emitting unit **650** includes three ACLED**1~3** having identical luminous power as well as switches **651** and **652**. In which, switches **651** and **652** may be relays. The parallel-connected ACLED**1** and ACLED**2** are series-connected to the switch **652** to produce double luminous power, and of which the ACLED**3** is parallel connected to, to generate triple luminous power, and of which an AC power source is further coupled to through the switch **651**. Moreover, the microcontroller **240** implements the loading and power control unit **140** of FIG. **1**. The pin PC and pin PS are respectively connected to switches **651** and **652** for outputting voltage signals to control the operations of switches **651** and **652** (i.e., open or close).

In the PC mode, the pin PC and pin PS of the microcontroller **240** control the switches **651** and **652** to be closed at same time. Consequently, the ACLED**1~3** are coupled to the AC power source and the light-emitting unit **650** may

generate a high level illumination of triple luminous power. After a short predetermined duration, the microcontroller **240** returns to PS mode. In which the switch **651** is closed while the pin PS controls the switch **652** to be opened, consequently, only the ACLED**3** is connected to AC power source, and the light-emitting unit **650** may thus generate the low level illumination of one luminous power. In the PS mode, when the motion sensor **230** detects a human motion, the microcontroller **240** temporarily closes the switch **652** to generate high level illumination with triple luminous power for a predetermined duration. After the predetermined duration, the switch **652** returns to open status thereby to generate the low level illumination of one luminous power. The lighting apparatus of FIG. **6** may therefore through controlling switches **651** and **652** generate two level illuminations with illumination contrast of at least 3 to 1.

The ACLED**1** and ACLED**2** of FIG. **6** may be high power lighting sources having color temperature of 5000K. The ACLED**3** may be a low power lighting source having color temperature of 2700K. Consequently, the ACLED may generate two levels of illuminations with high illumination and hue contrast without using a zero-crossing detection circuit.

Fifth Exemplary Embodiment

Refer to FIG. **7**, which illustrates a schematic diagram of a two-level LED security light in accordance to the fifth exemplary embodiment of the present disclosure. The light-emitting unit **750** of FIG. **7** is different from the light-emitting unit **640** of FIG. **6** in that the ACLED**3** is series-connected to a circuit with a rectified diode D and a switch **753** parallel-connected together, and of which is further coupled through a switch **751** to AC power source. When the switch **753** closes, the AC electric current that passes through the ACLED**3** may be a full sinusoidal waveform. When the switch **753** opens, the rectified diode rectifies the AC power, thus only one half cycle of the AC electric current may pass through the ACLED, consequently the luminous power of ALCED**3** is cut to be half.

The pin PS of the microcontroller **240** synchronously controls the operations of switches **752** and **753**. If the three ACLED**1~3** have identical luminous power, then in the PC mode, the pin PC and pin PS of the microcontroller **240** synchronously close the switches **751~753** to render ACLED**1~3** illuminating, thus the light-emitting unit **750** generates a high level illumination which is three-times higher than the luminous power of a single ACLED. When in the PS mode, the microcontroller **240** closes the switch **751** while opens switches **752** and **753**. At this moment, only the ACLED**3** illuminates and as the AC power source is rectified by the rectified diode D, thus the luminous power of ACLED**3** is half of the AC power source prior to the rectification. The luminous power ratio between the high level and the low level illuminations is therefore 6 to 1. Consequently, strong illumination contrast may be generated to effectively warn the intruder.

It should be noted that the light-emitting unit in the fifth exemplary embodiment is not limited to utilizing ACLEDs. In other words, the light-emitting unit may include any AC lighting sources such as ACLEDs, incandescent lamps, or fluorescent lamps.

A lighting apparatus may be implemented by integrating a plurality of LEDs with a microcontroller and various types of sensor components in the controlling circuit in accordance to the above described five exemplary embodiments. This lighting apparatus may automatically generate high level illumination when the ambient light detected is insufficient and time-switch to the low level illumination. In addition, when a person is entering the predetermined detection zone, the lighting apparatus may switch from the low level illumination to the high level illumination, to provide the person with sufficient illumination or to generate strong illumination and hue contrast for monitoring the intruder.

When the light source of the light emitting unit **150** is confined to the use of an LED load, the compliance and satisfaction of a voltage operating constraint attributable to the unique electrical characteristics of the LED load is vital to a successful performance of an LED lighting device. Any LED lighting device failing to comply with the voltage operating constraint of the unique electrical characteristics is bound to become a trouble art. This is because the LED as a kind of solid state light source has completely different electrical characteristics for performing light emission compared with conventional light source such as incandescent bulbs or fluorescent bulbs. For instance, for a white light or blue light LED there exists a very narrow voltage domain ranging from a threshold voltage at 2.5 volts to a maximum working voltage at 3.3 volts, which allows to operate adequately and safely the LED; in other words, when a forward voltage imposed on the LED is lower than the threshold voltage, the LED is not conducted and therefore no light is emitted, when the forward voltage exceeds the maximum working voltage, the heat generated by a forward current could start damaging the construction of the LED. Therefore, the forward voltage imposed on the LED is required to operate between the threshold voltage and the maximum working voltage.

In respect to the LED load of the light-emitting unit **150**, the cut-in voltage V_t of ACLEDs is technically also referred to as the threshold voltage attributable to PN junctions manufactured in LEDs. More specifically, the LED is made with a PN junction semiconductor structure inherently featured with three unique electrical characteristics, the first characteristic is one-way electric conduction through the PN junction fabricated in the LED, the second electrical characteristic is the threshold voltage V_{th} required to trigger the LED to start emitting light and the third electrical characteristic is a maximum working voltage V_{max} allowed to impose on the LED to avoid a thermal runaway to damage or burn out the semiconductor construction of the LED. The described cut-in voltage V_t has the same meaning as the above mentioned threshold voltage V_{th} which is a more general term to be used for describing the second electrical characteristic of a PN junction semiconductor structure. Also because the cut-in voltage V_t is specifically tied to forming a formula to transform the threshold voltage into a corresponding time phase of AC power for lighting control, it is necessary to use the term V_{th} as a neutral word for describing the LED electrical characteristics to avoid being confused with the specific application for ACLED alone. Additionally, it is to be clarified that the term V_m is related to the amplitude of the instant maximum voltage of an AC power source which has nothing to do with the third electrical characteristic V_{max} of an LED load.

An LED chip is a small piece of semiconductor material with at least one LED manufactured inside the semiconductor material. A plurality of LEDs may be manufactured and packaged inside an LED chip for different levels of wattage specification to meet different illumination need. For each LED chip designed with a different level of wattage specification there always exists a narrow voltage domain $V_{th}<V<V_{max}$, wherein V is a voltage across the LED chip, V_{th} is the threshold voltage to enable the LED chip to start

emitting light and V_{max} is the maximum working voltage allowed to impose on the LED chip to protect the LED chip from being damaged or burned out by the heat generated by a higher working voltage exceeding V_{max}.

For an LED load configured with a plurality of the LED chips in any LED lighting device, regardless such LED load being configured with ACLED chips or DC LED chips, the working Voltage V of each single LED chip is required to operate in a domain between a threshold voltage V_{th} and a maximum working voltage V_{max} or $V_{th}<V<V_{max}$ and the working voltage V_N of the LED load comprising N pieces of LED chips connected in series is therefore required to operate in a domain established by a threshold voltage of N times V_{th} ($N \times V_{th}$) and a maximum working voltage of N times V_{max} ($N \times V_{max}$) or $N \times V_{th}<V_N<N \times V_{max}$, wherein N is the number of the LED chips electrically connected in series. For any LED lighting device comprising an LED load it is required that the LED load in conjunction with an adequate level of power source is configured with a combination of in series and in parallel connections of LED chips such that the electric current passing through each LED chip of the LED load remains at an adequate level such that a voltage V across each LED chip complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED chip or a voltage V_N across the LED load configured with N number of LED chips connected in series complies with an operating constraint of $N \times V_{th}<V_N<N \times V_{max}$. Such narrow operating range therefore posts an engineering challenge for a circuit designer to successfully design an adequate level of power source and a reliable circuitry configured with an adequate combination of in series connection and in parallel connection of LED chips for operating a higher power LED security light.

FIGS. **8**A, **8**B, **8**C and **8**D comprises 4 drawings schematically and respectively showing a I-V relationship chart (Forward Current vs. Forward Voltage) for a white light LED chip from each of 4 different LED manufacturers; as can be seen from the chart when a forward voltage V is below a minimum forward voltage at around 2.5 volts, the LED chip is not conducted so the current I is zero, as the forward voltage exceeds 2.5 volts the LED chip is activated to generate a current flow to emit light, as the forward voltage continues to increase, the current I increases exponentially at a much faster pace, at a maximum forward voltage around 3.3 volts the current I becomes 250 mA which generates a heat that could start damaging the PN junction of the LED chip. The minimum forward voltage. i.e., the threshold voltage or the cut-in voltage, and the maximum forward voltage are readily available in the specification sheets at each of LED manufacturers, such as Cree, Lumileds, Samsung, Osram, and etc. Different LED manufacturers may have slightly different figures due to manufacturing process but the deviations of differences are negligible. The constraints of minimum forward voltage and maximum forward voltage represent physical properties inherent in any solid state light source. They are necessary matter for configuring any LED lighting products to ensure a normal performance of an LED load.

FIG. **9** is a data sheet showing data of the minimum forward voltages and maximum forward voltages collected from various LED manufacturers. They are fundamental requirements for configuring any LED lighting control devices to ensure a successful performance of any LED lighting device.

In summary, the compliance of voltage operating constraint $V_{th}<V<V_{max}$ featuring electrical characteristics of an LED chip is a critical technology for ensuring a normal performance of the LED load. Failing to comply with such voltage operating constraint can quickly age or seriously damage the semiconductor structure of the LED chip with a consequence of quick lumens depreciation of the LED bulbs and the product lifetime being substantially shortened, which will be unacceptable to the consumers. The compliance of the operating constraint $V_{th}<V<V_{max}$ is a necessary matter for any LED lighting device though it is not an obvious matter as it requires complicated technologies to calculate and coordinate among an adequate level of power source, a control circuitry and a non-linear light emitting load. For conventional lighting load such as incandescent bulb there exists no such operating constraint. This is why in the past years there had been many consumers complaining about malfunction of LED bulbs that the consumers were frustrated with the fast depreciation of lumens output and substantially shortened product lifetime of the LED bulbs purchased and used. A good example was a law suit case filed by the Federal Trade Commission on Sep. 7, 2010 (Case No. SACV10-01333 JVS) for a complaint against a leading lighting manufacturer for marketing deceptive LED lamps and making false claims with respect to the life time of their LED lamps and a huge amount, of monetary relief was claimed with the Court in the complaint.

The present disclosure of a two-level LED security light provides a unique life-style lighting solution. The motivation of creating such life-style lighting solution has less to do with the energy saving aspect of the low level illumination mode because an LED is already a very energy saving light source compared with the conventional incandescent light source. For instance, a 10-watt LED security light when operated at a low level at 30% illumination it only saves 7 watts, which is not as significant as a 100-watt incandescent bulb which can save as much as 70 watts when operated at 30% illumination for a low level mode. While it is always good to save some extra energy, it is however not the main incentives for developing the present invention; the life-style lighting solution of the present disclosure is featured with two innovations which meaningfully improve the exquisite tastes of living in the evening, the first innovation is the creation of an aesthetic scene for the outdoor living environment, wherein at dusk the LED security light is automatically turned on by the photo sensor to perform the low level illumination with a low color temperature which is necessary for creating a soft and aesthetic night scene for the outdoor living area (such soft and aesthetic night view is not achievable by the high level illumination however), the second innovation is the creation of a navigation capacity similar to a light house effect for guiding people to safely move toward a destination in the outdoor living area without getting lost or encountering an accident, wherein when a motion intrusion is detected by the motion sensor the security light is instantly changed to perform a high level illumination mode with a high color temperature light which offers people a high visibility of the surrounding environment when needed. For the visibility of a surrounding environment the high color temperature light is the winner while for the creation of a soft and aesthetic night view there is no substitute for the low color temperature light. It is the innovation of the present invention to configure a life-style security light with a low color temperature LED load and a high color temperature LED load respectively activated by a photo sensor and a motion sensor to resemble the natural phenomenon of a sun light. These two innovative functions ideally implemented by the LED loads coupled with the motion sensor to increase illumination with a high visibility when people enters into the short detection area make the

present invention a perfect life-style lighting solution for enjoying an exquisite taste of evening life.

The above-mentioned descriptions represent merely the exemplary embodiment of the present disclosure, without any intention to limit the scope of the present disclosure thereto. Various equivalent changes, alternations or modifications based on the claims of present disclosure are all consequently viewed as being embraced by the scope of the present disclosure.

What is claimed is:

1. A life-style two-level LED security light comprising:

a light-emitting unit configured with an LED load;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit; and

a power supply unit;

wherein the light-emitting unit includes a plurality of LEDs divided into two sets with a first set having N number LEDs and a second set having M number LEDs;

wherein the loading and power control unit includes a controller electrically coupled to the light sensing unit, the motion sensing unit and at least two switching devices including at least a first switching device and a second switching device;

wherein the first switching device and the second switching device are connected with the first set of N number LEDs and the second set of M number LEDs, wherein the first switching device and the second switching device are controlled by the controller to be conducting or cut-off to perform at least a first switching mode and a second switching mode;

wherein in the first switching mode the power supply unit drives at least the first set of N number LEDs to perform a low level illumination with low light intensity and in the second switching mode the power supply unit drives at least the second set of M number LEDs to perform a high level illumination with high light intensity;

wherein when an ambient light detected by the light sensing control unit is lower than a predetermined value, the loading and power control unit manages to turn on the first set of N number LEDs in the light-emitting unit to generate the low level illumination;

wherein when the ambient light detected by the light sensing control unit is higher than the predetermined value, the light-emitting unit is switched off;

wherein when a motion intrusion is detected by the motion sensing unit, the loading and power control unit manages to turn on at least the second set of M number LEDs to generate the high level illumination for a predetermined duration before resuming to the low level illumination; and

wherein the controller comprises at least a programmable integrated circuit device or an application specific integrated circuit.

2. The life-style two-level LED security light according to claim **1**, wherein when the second set of M number LEDs is turned on upon detecting the motion intrusion, the loading and power control unit continues to turn on the first set of N number LEDs.

3. The life-style two-level LED security light according to claim **1**, wherein when the second set of M number LEDs is turned on upon detecting the motion intrusion, the loading and power control unit manages to turn off the first set of N number LEDs.

4. The life-style two-level LED security light according to claim **1**, wherein the N number LEDs and the M number LEDs are non-detachably coupled to the switching devices.

5. The life-style two-level LED security light according to claim **1**, wherein the total wattage of the M number LEDs is greater than the total wattage of the N number LEDs.

6. The life-style two-level LED security light according to claim **1**, wherein the total wattage of the M number LEDs is equal to the total wattage of the N number LEDs.

7. The life-style two-level LED security light according to claim **1**, wherein the power supply unit outputs a DC power for operating the two-level LED security light, wherein the first set of N number LEDs and the second set of M number LEDs are connected in series, wherein a constant current control circuit is connected in series with the light-emitting unit to convert the DC power into the constant current such that the current level remains stable in light of a drastic change of lighting load between driving the N number LEDs for generating the low level illumination and driving the M number LEDs for generating the high level illumination, wherein the level of constant current is designed such that a voltage across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED load;

wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum voltage across each LED to avoid a thermal damage to the LED construction.

8. The life-style two-level LED security light according to claim **7**,

wherein when the two-level LED security is operated in the low level illumination mode, the light intensity is further adjustable by the controller;

wherein the first set of N number LEDs is configured to include a plurality of switching devices respectively coupled to the two ends of each LED and to the controller, wherein the controller is configured to control the number of LEDs to be turned on in the N number LEDs through bypassing unwanted LEDs in the N number LEDs respectively with the associated switching device(s) according, to an external control signal played by an user or according to a value of a voltage divider set by the user.

9. The life-style two-level LED security light according to claim **7**, wherein when the two-level LED security is in the high level illumination mode, the light intensity is further adjustable by the controller, wherein the second set of M number LEDs is configured to include a plurality of switching devices respectively coupled to the two ends of each LED and to the controller, wherein the controller is configured to control the number of LEDs to be turned on in the M number LEDs through bypassing unwanted LEDs in the M number LEDs respectively with the associated switching device(s) according to an external control signal played by an user or according to a value of a voltage divider set by the user.

10. The life-style two-level LED security light according to claim **1**,

wherein the power supply unit outputs a DC power for operating the two-level LED security light;

wherein the first set of N number LEDs and the second set of M number LEDs are connected in parallel, wherein the first switching device is electrically connected in series between the first set of N number LEDs and the power supply unit, wherein the second switching

device is electrically connected in series between the second set of M number LEDs and the power supply unit;

wherein the first set of N number LEDs and the second set of M number LEDs in conjunction with the power supply unit are respectively designed with a configuration of in series and in parallel connections of LEDs such that e an electric current passing through each LED of the light emitting unit remains at an adequate level, and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED load;

wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum voltage across each LED to avoid a thermal damage to the LED construction.

11. The life-style two-level LED security light according, to claim **10**, wherein when the LED load is configured with a plurality of LEDs or sets of LEDs electrically connected in series, a working voltage across the LED load is confined in a domain between a minimum voltage equal to the total sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the total sum of the maximum voltages of all LEDs or sets of LEDs electrically connected in series.

12. The life-style two-level LED security light according to claim **10**, wherein when the two-level LED security light is in the low level illumination mode, the light intensity of the low level illumination mode is further adjustable by the controller; wherein the controller in response to an external control signal played by an user outputs a PWM signal to control a time length of conduction period of the first switching device in each duty cycle such that an average electric current proportional to the time length of the conduction period is delivered to the light: emitting unit for performing a dimming work of the low level illumination mode.

13. The life-style two-level LED security light according to claim **10**, wherein when the two-level LED security light is in the high level illumination mode, an illumination of the high level illumination mode is further adjustable by the controller; wherein the controller in response to an external control signal played by an user outputs at least a PWM signal to control a time length of conduction period of at least the second switching device in each duty cycle such that an average electric current proportional to the time length of the conduction period is delivered to the light-emitting unit for performing the illumination of the high level illumination mode.

14. The life-style two-level LED security light according to claim **10**, wherein when the two-level LED security light is in the high level illumination mode, an illumination of the high level illumination mode is further adjustable by the controller; wherein the controller in response to an external control signal played by an user outputs PWM signals to control time lengths of conduction period of both the first switching device and the second switching device in each duty cycle such that average electric currents proportional to the time lengths of the conduction period are delivered to the light emitting unit for performing the illumination of the high level illumination mode.

15. A life-style two-level LED security light comprising:

a light-emitting unit configured with an LED load;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit; and

a power supply unit;

wherein the LED load of the light-emitting unit includes a plurality of LEDs divided into two sets with the first set having N number LEDs and the second set having M number LEDs;

wherein the loading and power control unit includes a microcontroller electrically coupled to the light sensing unit, the motion sensing unit and at least two switching devices including a first switching device and a second switching device;

wherein the first switching device and the second switching device are connected with the first set of N number LEDs and the second set of M number LEDs;

wherein the two switching devices are controlled by the microcontroller to be respectively conducting or cut-off to perform at least a first switching mode and a second switching mode;

wherein in the first switching mode at least the first set of N number LEDs is turned on to perform a low level illumination with low light intensity and in the second switching mode at least the second set of M number LEDs is turned on to perform a high level illumination with high light intensity;

wherein when an ambient light detected by the light sensing control unit is lower than a predetermined value, the loading and power control unit manages to turn on the first set of N number LEDs in the light-emitting unit to generate the low level illumination;

wherein when the ambient light detected by the light sensing control unit is higher than the predetermined value, the LED load is switched off;

wherein when a motion intrusion is detected by the motion sensing unit, the loading and power control unit manages to turn on at least the second set of M number LEDs in the light-emitting unit to generate the high level illumination for a predetermined duration; and

wherein the N number LEDs emit light with a low color temperature to produce a soft evening light to feature an aesthetic night view around the living area both for indoor and outdoor need while at the same time create a navigation capacity similar to a light house to help people move to a destination without getting lost or encountering an accident, wherein the M number LEDs emit light with a high color temperature to produce a much brighter day light with a dual effect of security alert by means of creating drastic changes in both light intensity from low to high and light color temperature from warm to cool upon detecting a motion intrusion, wherein the high level illumination with a day light high color temperature enables people to have a high visibility of the surrounding environment when needed.

16. The life-style two-level LED security light according to claim **15**, wherein when the second set of M number LEDs is turned on upon detecting the motion intrusion, the loading and power control unit continues to turn on the first set of N number LEDs.

17. The life-style two-level LED security light according to claim **15**, wherein when the second set of M number LEDs is turned on upon detecting the motion intrusion, the loading and power control unit manages to turn off the first set of N number LEDs.

18. The life-style two-level LED security light according to claim **15**, wherein the total wattage of the M number LEDs is greater than the total wattage of the N number LEDs.

19. The life-style two-level LED security light according to claim **15**, wherein the total wattage of the M number LEDs is equal to the total wattage of the N number LEDs.

20. The life-style two-level LED security light according to claim 15, wherein the power supply unit outputs a DC power for operating the life-style two-level LED security light, wherein the first set of N number LEDs and the second set of M number LEDs are connected in series, wherein a constant current control circuit is connected in series with the light-emitting unit to convert the DC power into the constant current such that a current level remains stable in light of a drastic change of lighting load between driving the N number LEDs for generating the low level illumination and driving the M number LEDs for generating the high level illumination, wherein the current level of constant current is designed such that a voltage across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED load;

wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum voltage across each LED to avoid a thermal damage to the LED construction.

21. The life-style two-level LED security light according to claim 20,

wherein when the life-style two-level LED security is operated in the low level illumination mode, the light intensity is further adjustable by the microcontroller;

wherein the first set of N number LEDs is configured to include a plurality of switching devices respectively coupled to the two ends of each LED and to the microcontroller, wherein the microcontroller is configured to control the number of LEDs to be turned on in the N number LEDs through bypassing unwanted LEDs in the N number LEDs respectively with the associated switching device(s) according to an external control signal played by an user or according to a value of a voltage divider set by the user.

22. The life-style two-level LED security light according to claim 20, wherein when the two-level LED security is in the high level illumination mode, the light intensity is further adjustable by the microcontroller, wherein the second set of M number LEDs is configured to include a plurality of switching devices respectively coupled to the two ends of each LED and to the microcontroller, wherein the microcontroller is configured to control the number of LEDs to be turned on in the M number LEDs through bypassing unwanted LEDs in the M number LEDs respectively with the associated switching device(s) according to an external control signal played by an user or according to a value of a voltage divider set by the user.

23. The life-style two-level LED security light according to claim 15,

wherein the power supply unit outputs a DC power for operating the two-level LED security light;

wherein the first set of N number LEDs and the second set of M number LEDs are connected in parallel, wherein the first switching device is electrically connected in series between the first set of N number LEDs and the power supply unit, wherein the second switching device is electrically connected in series between the second set of M number LEDs and the power supply unit;

wherein the first set of N number LEDs and the second set of M number LEDs in conjunction with the power supply unit are respectively designed such that an electric current passing through each LED of the light-emitting unit remains at an adequate level, and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED load;

wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum voltage across each LED to avoid a thermal damage to the LED construction.

24. The life-style two-level LED security light according to claim 23, wherein when the LED load is configured with a plurality of LEDs or sets of LEDs electrically connected in series, a working voltage across the LED load is confined in a domain between a minimum voltage equal to the total sum of the threshold voltages of all LEDs or sets of LEDs electrically connected in series and a maximum voltage equal to the total sum of the maximum voltages of all LEDs or sets of LEDs electrically connected in series.

25. The life-style two-level LED security light according to claim 23, wherein when the life-style two-level LED security light is in the low level illumination mode, the light intensity of the low level illumination mode is further adjustable by the microcontroller; wherein the microcontroller in response to an external control signal played by an user outputs a PWM signal to control a time length of conduction period of the first switching device in each duty cycle such that an average electric current proportional to the time length of the conduction period is delivered to the light-emitting unit for performing a dimming work of the low level illumination mode.

26. The life-style two-level LED security light according to claim 23, wherein when the life-style two-level LED security light is in the high level illumination mode, an illumination of the high level illumination mode is further adjustable by the microcontroller; wherein the microcontroller in response to an external control signal played by an user outputs at least a PWM signal to control a time length of conduction period of at least the second switching device in each duty cycle such that an average electric current proportional to the time length of the conduction period is delivered to the light-emitting unit for performing the illumination of the high level illumination mode.

27. The life-style two-level LED security light according to claim 23, wherein when the life-style two-level LED security light is in the high level illumination mode, an illumination of the high level illumination mode is further adjustable by the microcontroller; wherein the microcontroller in response to an external control signal played by an user outputs PWM signals to control time lengths of conduction period of both the first switching device and the second switching device in each duty cycle such that average electric currents proportional to the time lengths of the conduction period are delivered to the light: emitting unit for performing the illumination of the high level illumination mode.

28. The life-style two-level LED security light according to claim 27, wherein when the life-style two-level LED security light is in the high level illumination mode, the light intensity of the illumination is further adjustable by the microcontroller, wherein the microcontroller in response to the external control signal outputs PWM signals to control time lengths of conduction period of both the first switching device and the second switching device varying with the same pace in an adequate range for adjusting the light intensity of the high level illumination mode.

29. The life-style two-level LED security light according to claim 27, wherein when the life-style two-level LED security light is in the high level illumination mode, the light color temperature of the illumination is further adjustable by the microcontroller, wherein the microcontroller in response to the external control signal outputs PWM signals to control time lengths of conduction period of the first switching

device and the second switching device varying reversely in an adequate range such that controlling the light intensity of the first set of N number LEDs with the low color temperature and the light intensity of the second set of M number LEDs with the high color temperature varying simultaneously but reversely to produce a variable mingled color temperature through a light diffuser in such a manner for adjusting the light color temperature of the high level illumination mode.

30. The life-style two-level LED security light according to claim **23**, wherein when the N number LEDs and the M number LEDs are both in conduction state, the light intensity of the N number LEDs and the the intensity of the M number LEDs are respectively adjustable, wherein the microcontroller in response to an external control signal played by an user outputs a first PWM signal to control a conduction rate of the first switching device and a second PWM signal to control the conduction rate of the second switching device with an arrangement that the conduction rate of the first switching device and the conduction rate of the second switching device are reversely adjusted with the same pace such that the total power level transmitted to the N number LEDs and the M number LEDs is maintained at a constant level while a mingled color temperature of the light emitted by the N number LEDs and the light emitted by the M number LEDs thru a light diffuser is proportionately adjusted according to the external control signal to perform a color temperature tuning mode.

31. The life-style two-level LED security light according to claim **23**, wherein when the N number LEDs and the M number LEDs are both in conduction state, the light intensity of the N number LEDs and the light intensity of the M number LEDs are respectively adjustable, wherein the microcontroller in response to an external control signal played by an user outputs a first PWM signal to control a conduction rate of the first switching device and a second PWM signal to control the conduction rate of the second switching device with an arrangement that the conduction rate of the first switching device and the conduction rate of the second switching device are unidirectionally and proportionally adjusted with the same pace such that a mingled color temperature of the light emitted by the N number LEDs and the light emitted by the M number LEDs thru a light diffuser is maintained at a constant level while the light intensity of the light-emitting unit is being proportionately adjusted according to the external control signal to perform a dimming mode.

32. The life-style two-level LED security according to claim **23**, wherein when the N number LEDs and the M number LEDs are in conduction state, the light intensity and the light color temperature are both adjustable for performing a dimming and color temperature tuning control mode, wherein the microcontroller in response to an external control signal played by an user outputs a second PWM signal to control a conduction rate of the second switching device such that the M number LEDs with the high color temperature are dimmed according to the external control signal, wherein the microcontroller manages to output a first PWM signal to control a conduction state of the first switching device such that the N number LEDs with the low color temperature operates a constant power while the M number LEDs are being dimmed to create a dim to warm effect, wherein during a cycle of the dimming and color temperature tuning control mode, the light intensity and the light color temperature of the light-emitting unit are jointly determined by the external control signal.

33. The life-style two-level LED security according to claim **32**, wherein when the M number LEDs are dimmed to a cutoff state, the microcontroller operates to change the first PWM signal to continuously reduce the conduction rate of the first switching device such that the light intensity continues to decrease with the low color temperature.

34. The life-style two-level LED security light according to claim **23**, wherein when the N number LEDs and the M number LEDs are in conduction state, the light intensity and the light color temperature are both adjustable for performing a dimming and color temperature tuning control mode, wherein the microcontroller in response to an external control signal outputs a first PWM signal to control a conduction rate of the first switching device and a second PWM signal to control the conduction rate of the second switching device, wherein the first PWM signal and the second PWM signal are configured to operate with an arrangement that the M number LEDs and the N number LEDs are respectively dimmed in such a way that the M number LEDs leads the N number LEDs in reaching a turn off state in performing the dimming and color temperature tuning control mode such that a mingled color temperature of the light emitted by the N number LEDs and the light emitted by the M number LEDs continues to change to a warmer illumination along with a continuous reduction of light intensity to create a dim to warm effect according to the external control signal, wherein during a cycle of the dimming and color temperature turning control mode, the light intensity and the mingled color temperature of the light-emitting unit are jointly determined by the external control signal.

* * * * *

EXHIBIT E

US010516292B2

(12) **United States Patent**
Chen

(10) **Patent No.: US 10,516,292 B2**
(45) **Date of Patent: *Dec. 24, 2019**

(54) **TWO-LEVEL LED SECURITY LIGHT WITH MOTION SENSOR**

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(72) Inventor: **Chia-Teh Chen**, Taipei (TW)

(73) Assignee: **Vaxcel International Co., Ltd.**, Carol Stream, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

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(22) Filed: **Jan. 10, 2019**

(65) **Prior Publication Data**

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H05B 37/02 (2006.01)
H02J 7/35 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H02J 7/35*** (2013.01); ***F21S 9/03*** (2013.01); ***F21V 17/02*** (2013.01); ***G08B 5/36*** (2013.01); ***G08B 13/1895*** (2013.01); ***G08B 15/00*** (2013.01); ***G08B 15/002*** (2013.01); ***H05B 33/083*** (2013.01); ***H05B 33/0809*** (2013.01); ***H05B 33/0815*** (2013.01); ***H05B 33/0818*** (2013.01); ***H05B 33/0824*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H05B 37/0218; H05B 37/0227; H05B 37/0281; H05B 37/0272; H05B 33/0815; H05B 33/0824; H05B 33/083; H05B 33/0845; H05B 33/0854; H05B 33/0872
USPC 315/149, 152, 154, 307, 308, 312
See application file for complete search history.

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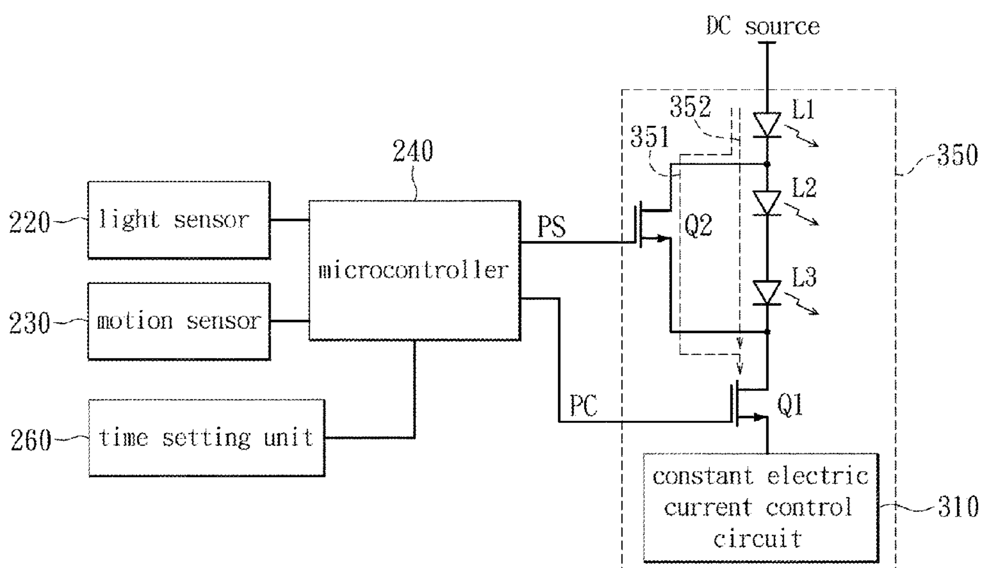
Primary Examiner — Tung X Le
(74) *Attorney, Agent, or Firm* — Rosenberg, Klein & Lee

(57) **ABSTRACT**

A lifestyle LED security light including a light-emitting unit configured with two sets of LED loads respectively emitting different color temperature lights is disclosed. At dusk the light-emitting unit is automatically turned on for a first level illumination with a low color temperature light featuring an aesthetic night view with the motion sensor being deactivated for a time duration, and then the light emitting unit is changed to a second level illumination and at the same time the motion sensor is activated, wherein when the motion sensor detects a motion intrusion, the light-emitting unit is instantly switched to perform a third level illumination with a a high light intensity and a high color temperature light. The color temperatures of the first level illumination and the third level illumination are respectively adjustable by simultaneously and reversely adjusting the electric powers respectively allocated to the two sets of LED loads.

89 Claims, 18 Drawing Sheets



Related U.S. Application Data

continuation of application No. 15/785,658, filed on Oct. 17, 2017, now Pat. No. 10,326,301, which is a continuation of application No. 15/375,777, filed on Dec. 12, 2016, now Pat. No. 9,826,590, which is a continuation of application No. 14/836,000, filed on Aug. 26, 2015, now Pat. No. 9,622,325, which is a division of application No. 14/478,150, filed on Sep. 5, 2014, now Pat. No. 9,445,474, which is a continuation of application No. 13/222,090, filed on Aug. 31, 2011, now Pat. No. 8,866,392.

(51) **Int. Cl.**

H05B 33/08	(2006.01)
G08B 15/00	(2006.01)
H05B 39/04	(2006.01)
F21S 9/03	(2006.01)
F21V 17/02	(2006.01)
G08B 5/36	(2006.01)
G08B 13/189	(2006.01)
F21Y 115/10	(2016.01)
G08B 13/00	(2006.01)

(52) **U.S. Cl.**

CPC ***H05B 33/0827*** (2013.01); ***H05B 33/0854*** (2013.01); ***H05B 33/0872*** (2013.01); ***H05B 37/02*** (2013.01); ***H05B 37/0218*** (2013.01); ***H05B 37/0227*** (2013.01); ***H05B 37/0281*** (2013.01); ***H05B 39/042*** (2013.01); ***H05B 39/044*** (2013.01); *F21Y 2115/10* (2016.08); *G08B 13/00* (2013.01); *G08B 13/189* (2013.01); *Y02B 20/40* (2013.01); *Y02B 20/44* (2013.01); *Y02B 20/46* (2013.01)

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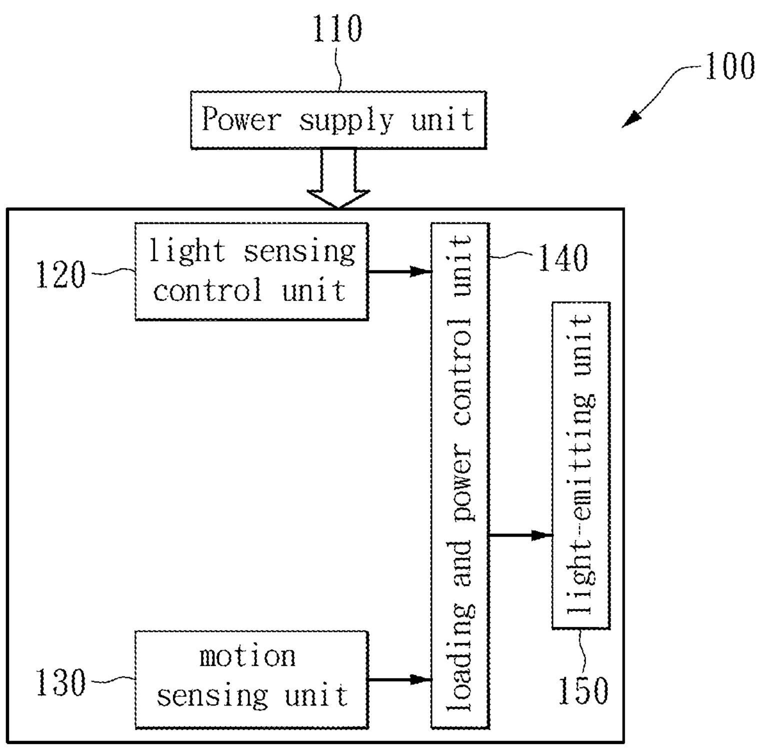

110
100
Power supply unit
light sensing control unit
120
140
loading and power control unit
light-emitting unit
motion sensing unit
130
150

FIG. 1

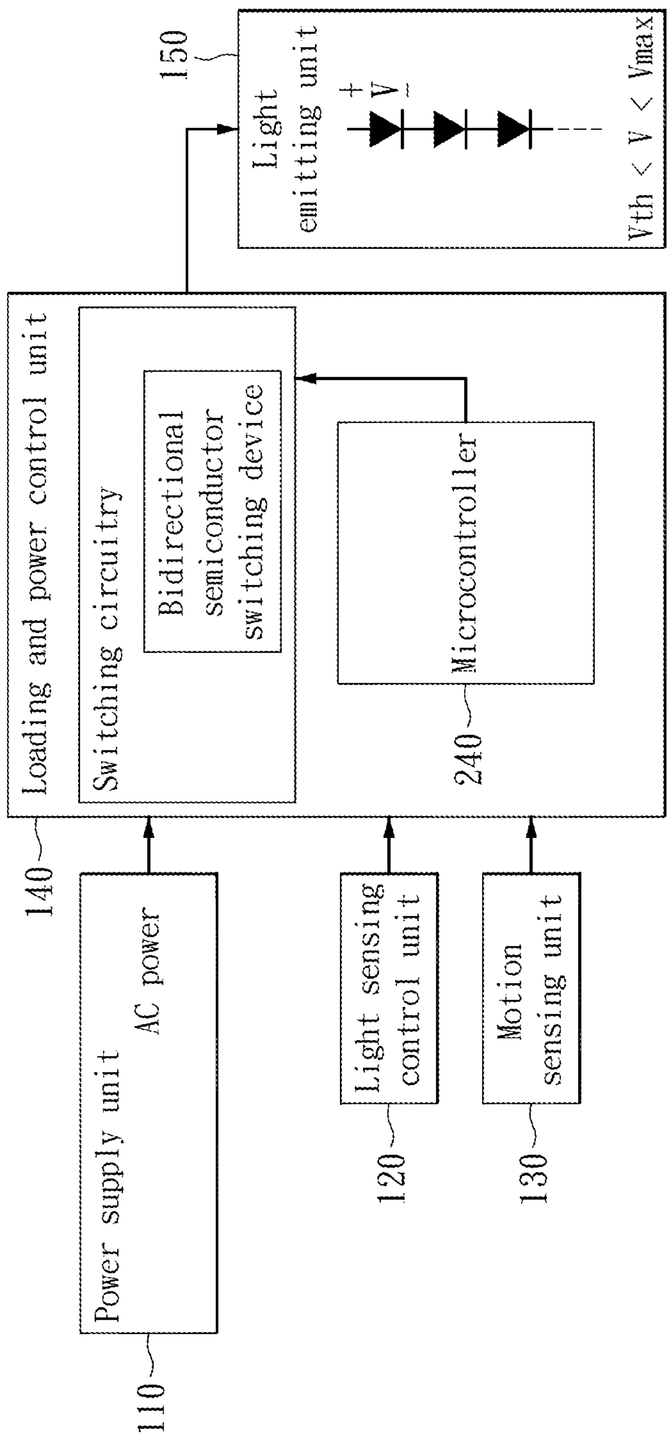
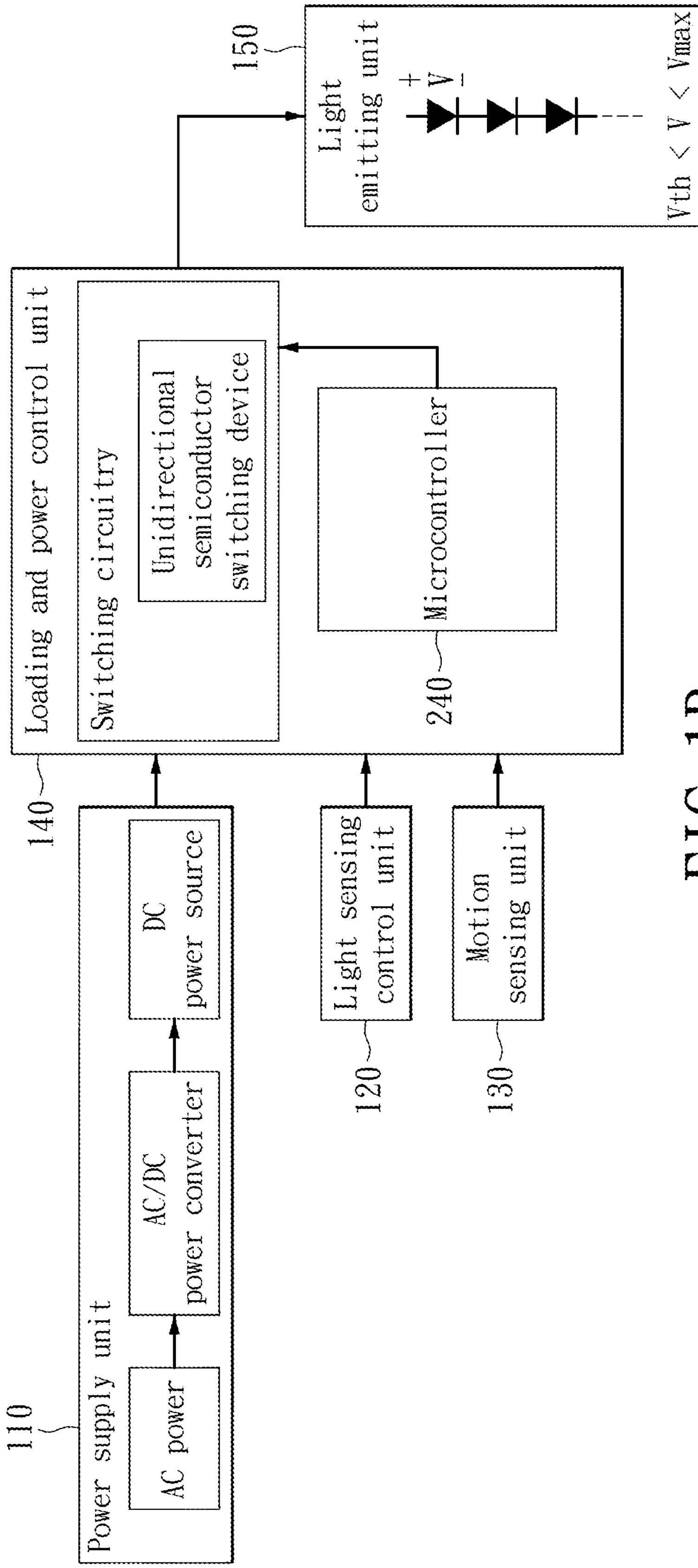

150
Light emitting unit
+ V −
Vth < V < Vmax
140
Loading and power control unit
Switching circuitry
Bidirectional semiconductor switching device
Microcontroller
240
110
Power supply unit
AC power
120
Light sensing control unit
130
Motion sensing unit

FIG. 1A



150
Light emitting unit
+ V −
Vth < V < Vmax
Loading and power control unit
Switching circuitry
Unidirectional semiconductor switching device
Microcontroller
240
140
Power supply unit
AC power
AC/DC power converter
DC power source
110
Light sensing control unit
120
Motion sensing unit
130

FIG. 1B

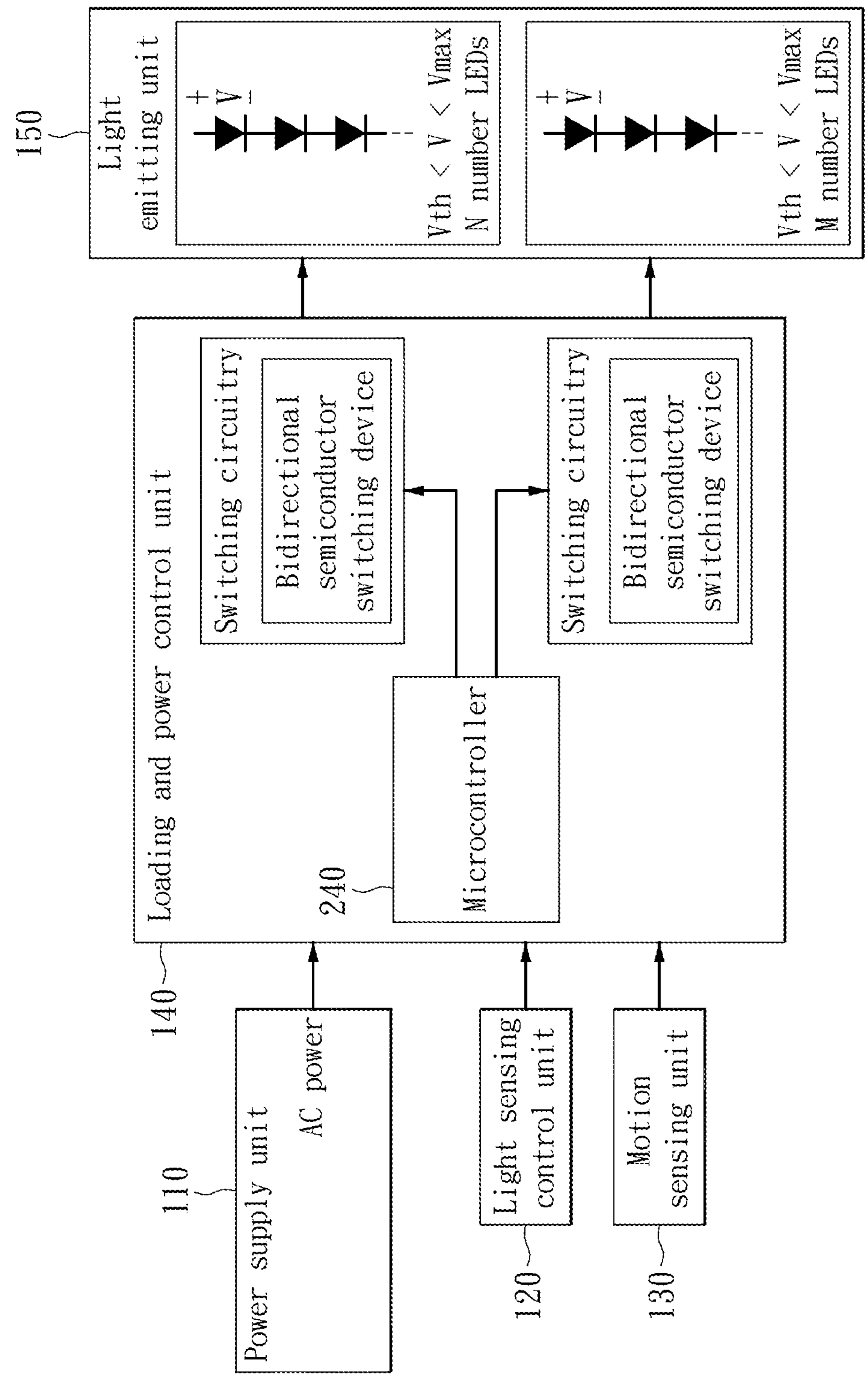

150
Light emitting unit
+ V −
Vth < V < Vmax
N number LEDs
+ V −
Vth < V < Vmax
M number LEDs
Loading and power control unit
Switching circuitry
Bidirectional semiconductor switching device
Switching circuitry
Bidirectional semiconductor switching device
240
Microcontroller
140
110
Power supply unit
AC power
Light sensing control unit
120
Motion sensing unit
130

FIG. 1C

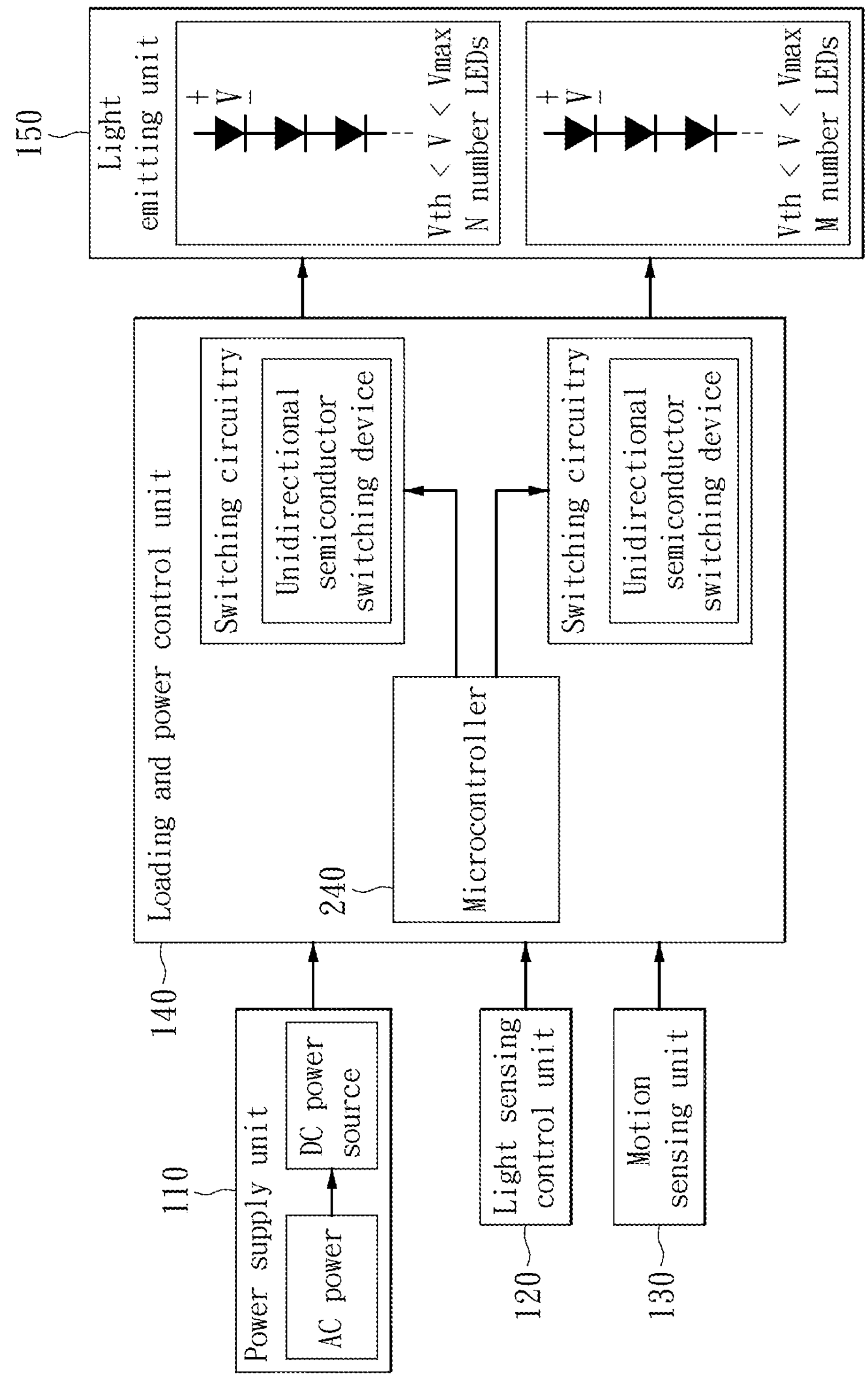

150
Light emitting unit
Vth < V < Vmax
N number LEDs
Vth < V < Vmax
M number LEDs
Loading and power control unit
Switching circuitry
Unidirectional semiconductor switching device
Switching circuitry
Unidirectional semiconductor switching device
240
Microcontroller
140
110
Power supply unit
AC power
DC power source
Light sensing control unit
120
Motion sensing unit
130

FIG. 1D

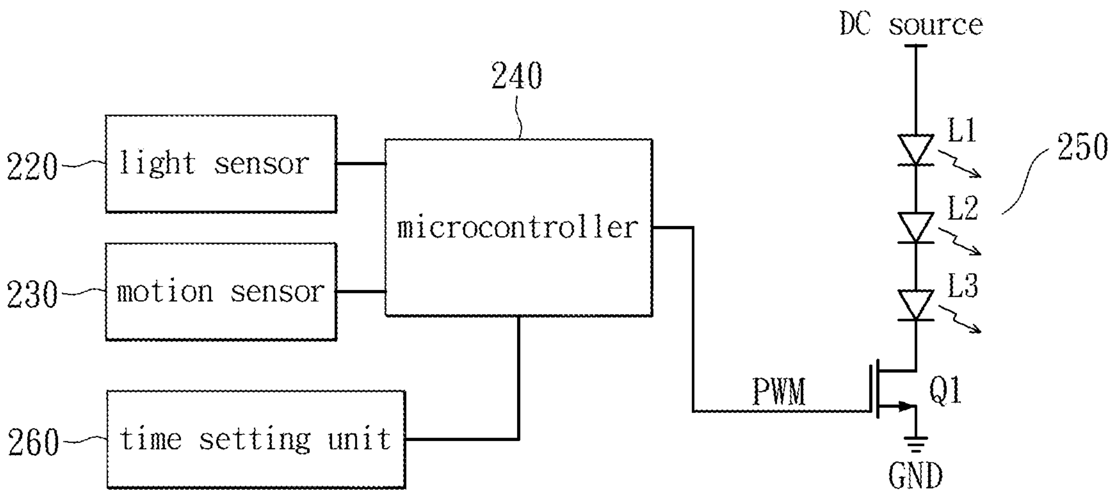

DC source
240
220
light sensor
microcontroller
L1
250
L2
230
motion sensor
L3
260
time setting unit
PWM
Q1
GND

FIG. 2A

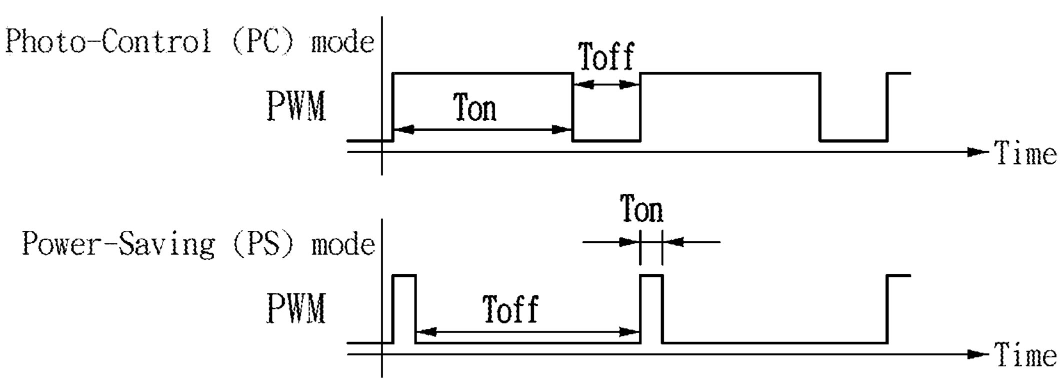


Photo-Control (PC) mode
Toff
PWM
Ton
Time
Ton
Power-Saving (PS) mode
PWM
Toff
Time

FIG. 2B

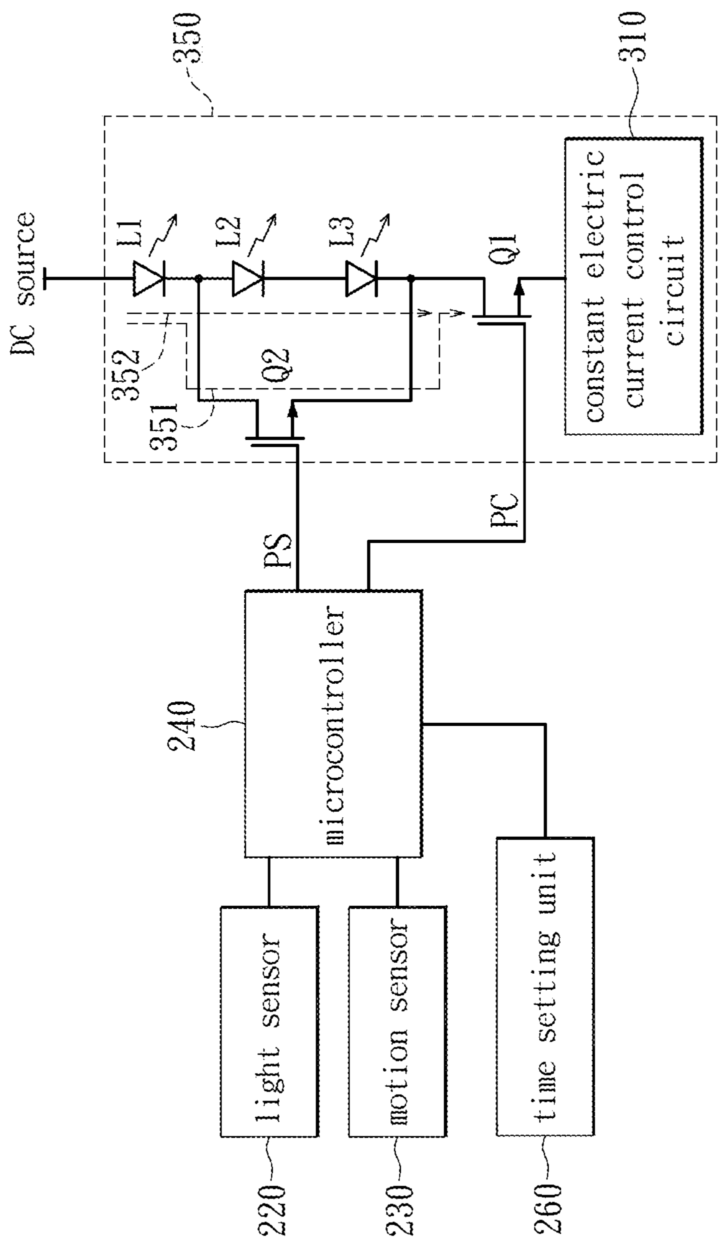

DC source
L1
L2
L3
Q1
Q2
350
310
352
351
constant electric current control circuit
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 3A

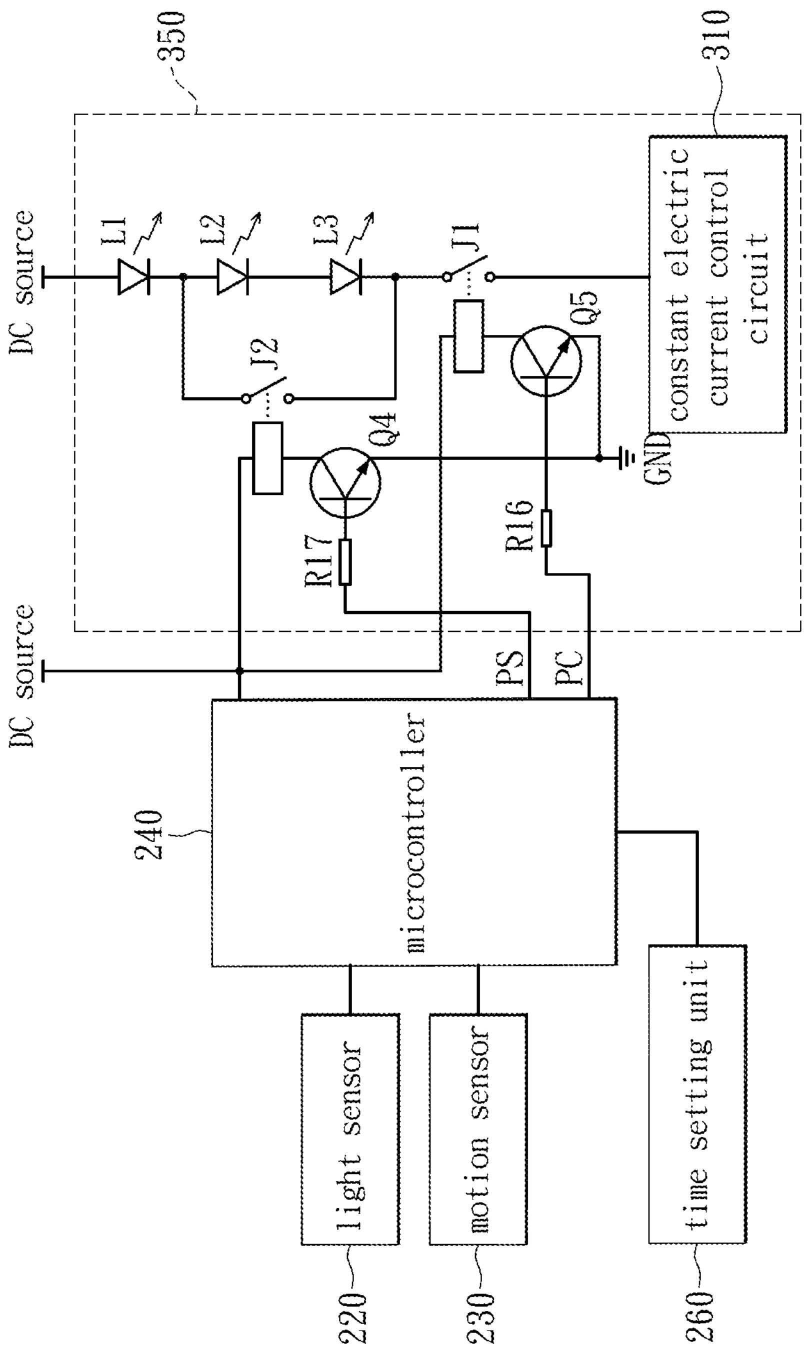

350
310
DC source
L1
L2
L3
J1
J2
Q4
Q5
R16
R17
GND
constant electric current control circuit
DC source
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 3B

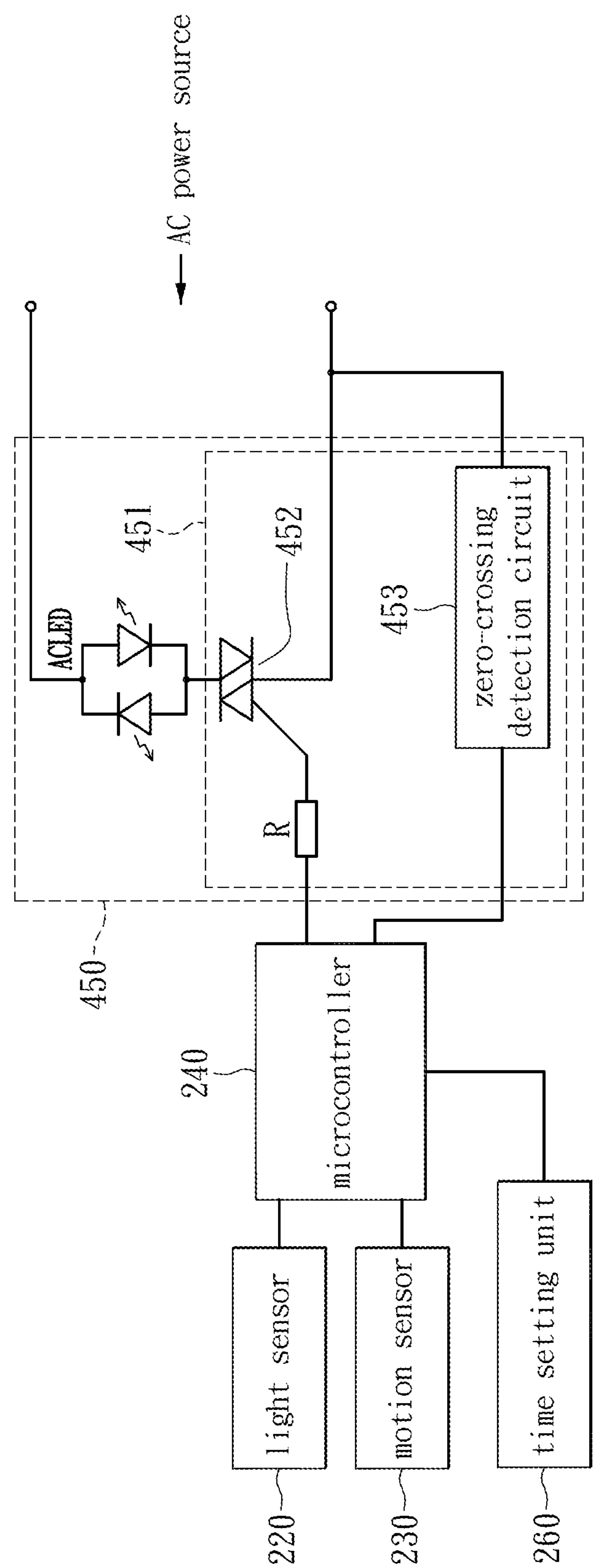

AC power source
ACLED
451
452
453
zero-crossing
detection circuit
R
450
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 4A

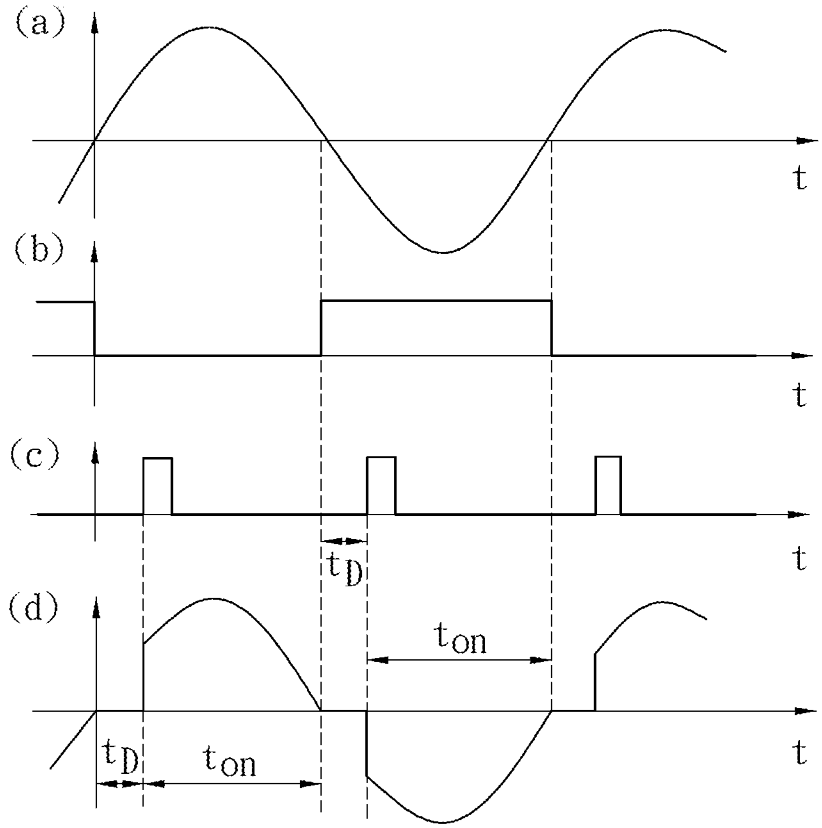


FIG. 4B

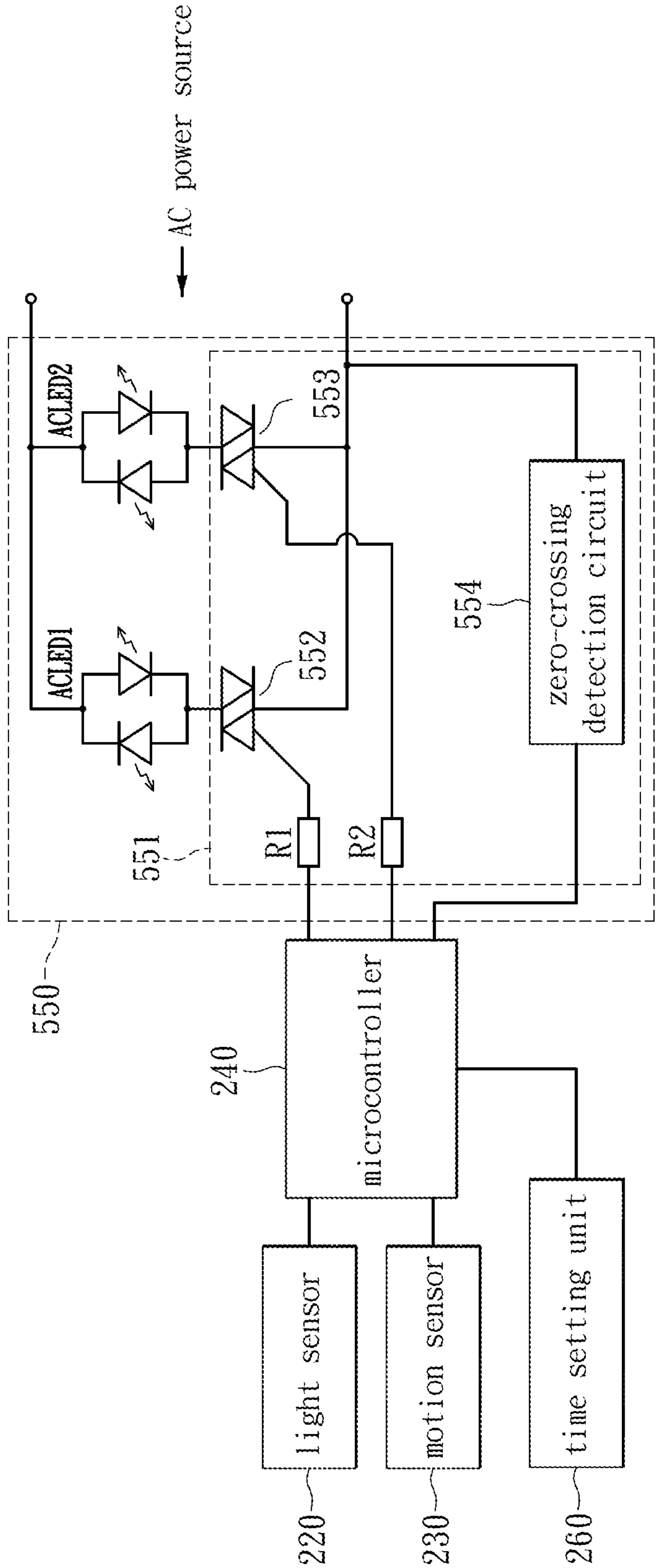

AC power source
ACLED2
ACLED1
553
552
554
zero-crossing detection circuit
551
R1
R2
550
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 5

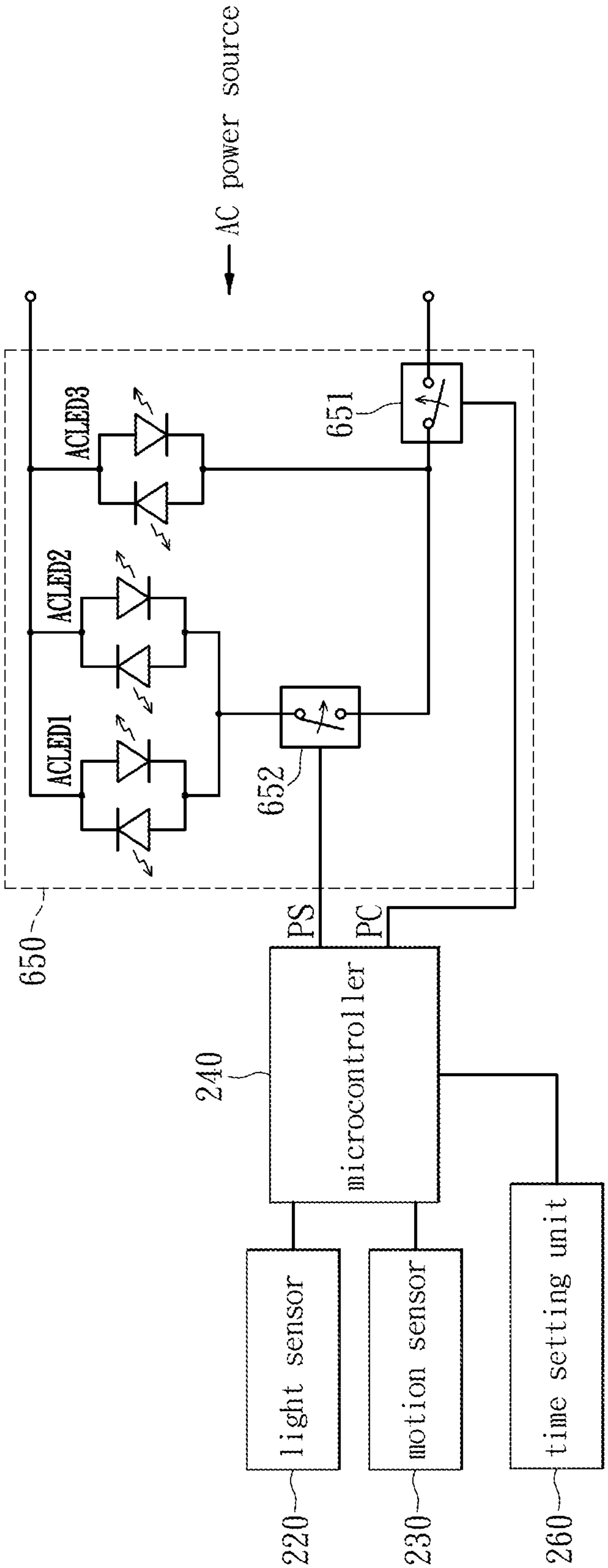

AC power source
ACLED1
ACLED2
ACLED3
651
652
650
PS
PC
240
microcontroller
light sensor
motion sensor
time setting unit
220
230
260

FIG. 6

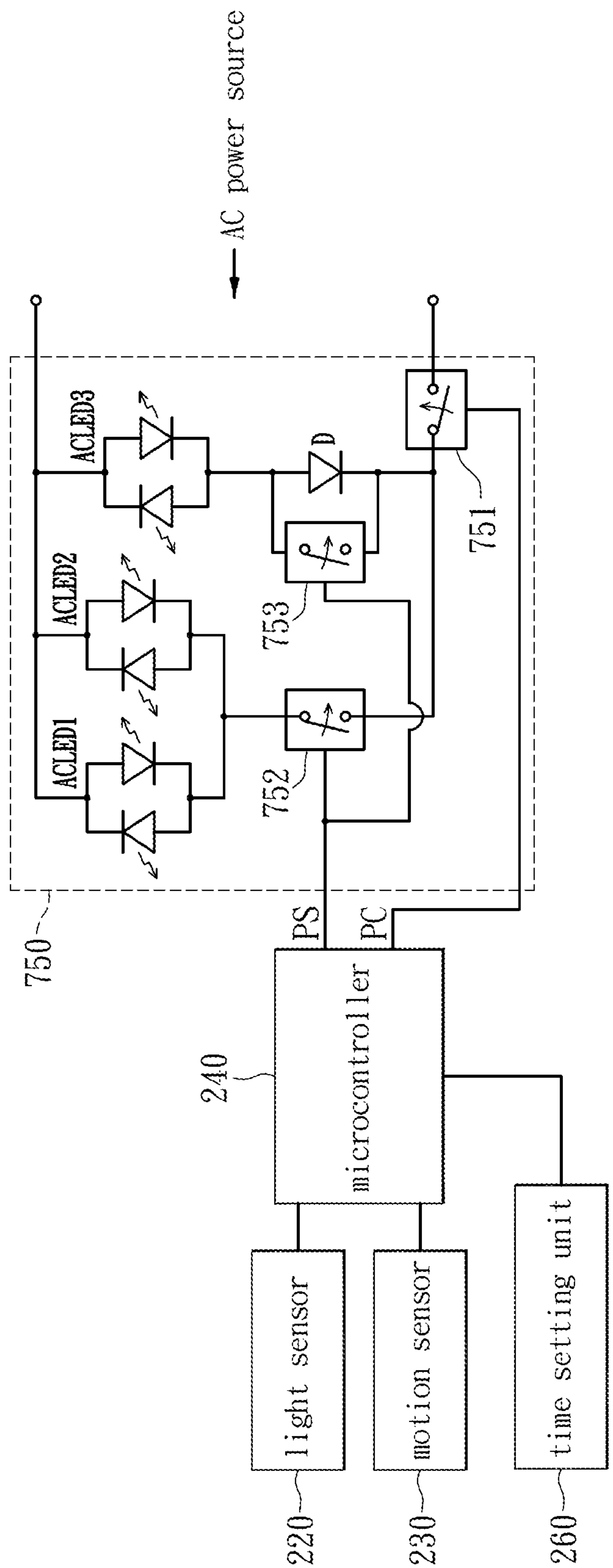

AC power source
ACLED1
ACLED2
ACLED3
D
750
751
752
753
PS
PC
microcontroller
240
light sensor
motion sensor
time setting unit
220
230
260

FIG. 7

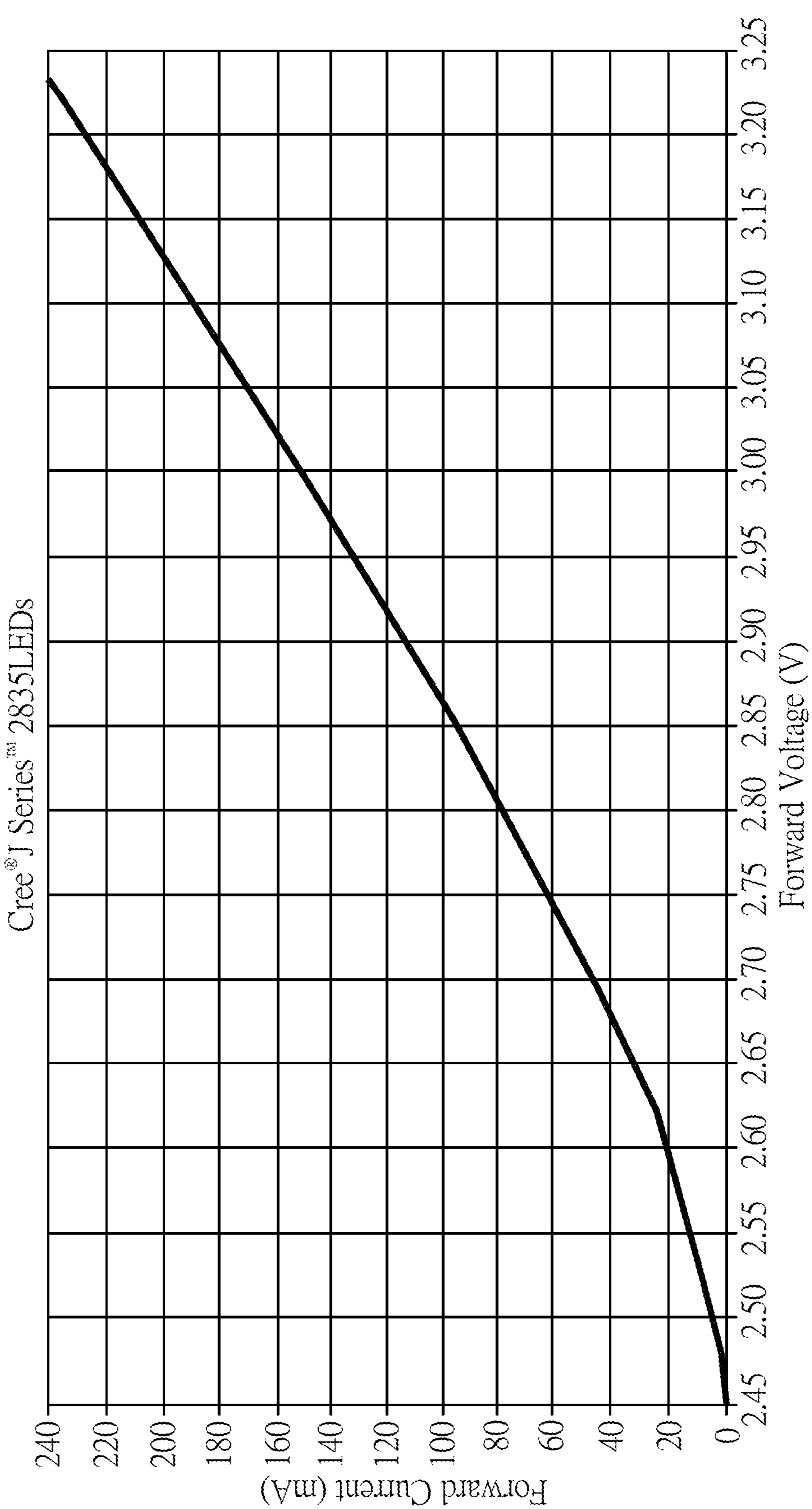

Cree® J Series™ 2835LEDs
Forward Current (mA)
240
220
200
180
160
140
120
100
80
60
40
20
0
Forward Voltage (V)
2.45
2.50
2.55
2.60
2.65
2.70
2.75
2.80
2.85
2.90
2.95
3.00
3.05
3.10
3.15
3.20
3.25

FIG. 8A

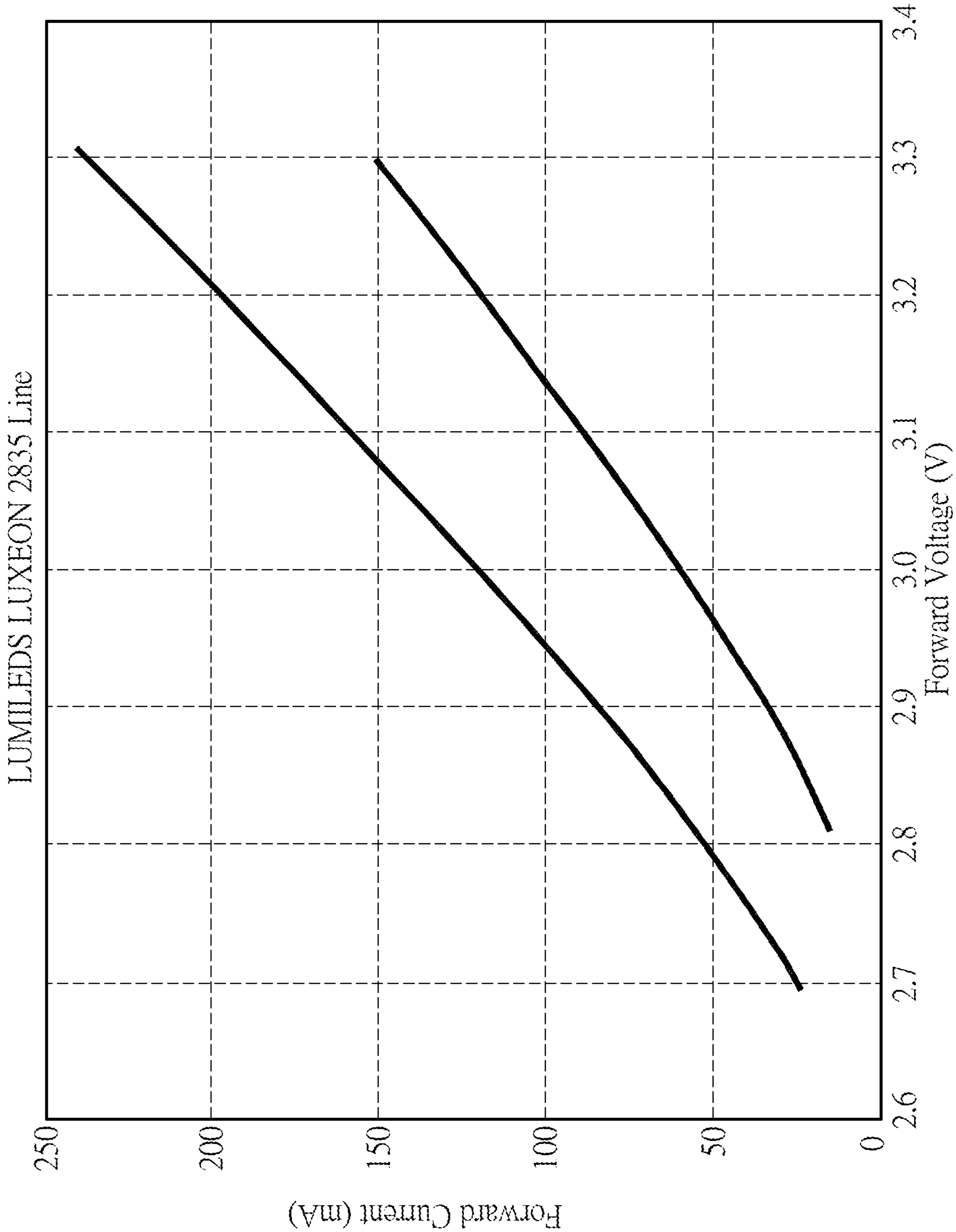
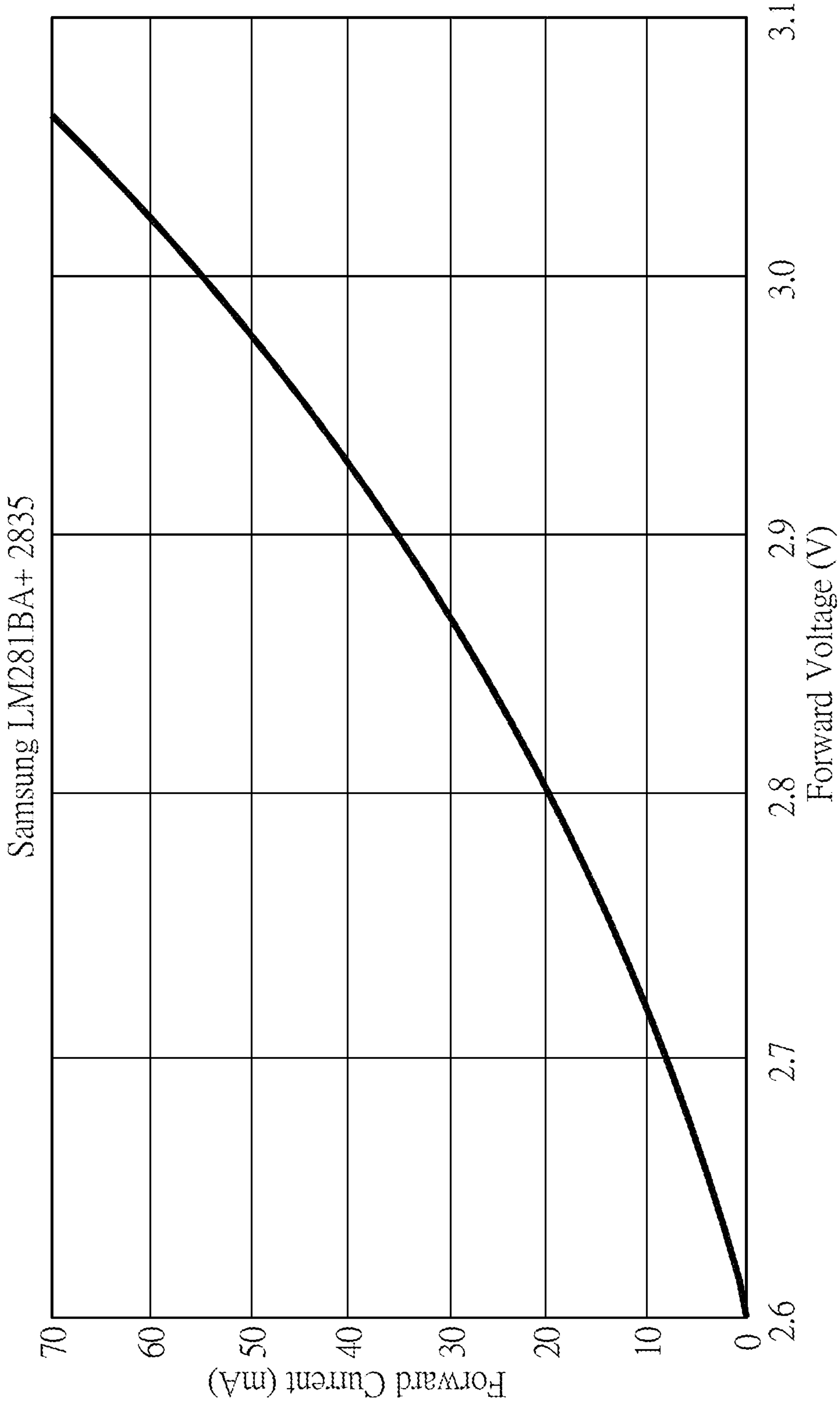

LUMILEDS LUXEON 2835 Line
Forward Current (mA)
250
200
150
100
50
0
Forward Voltage (V)
2.6
2.7
2.8
2.9
3.0
3.1
3.2
3.3
3.4

FIG. 8B



Samsung LM281BA+ 2835
70
60
50
40
30
20
10
0
Forward Current (mA)
2.6
2.7
2.8
2.9
3.0
3.1
Forward Voltage (V)

FIG. 8C

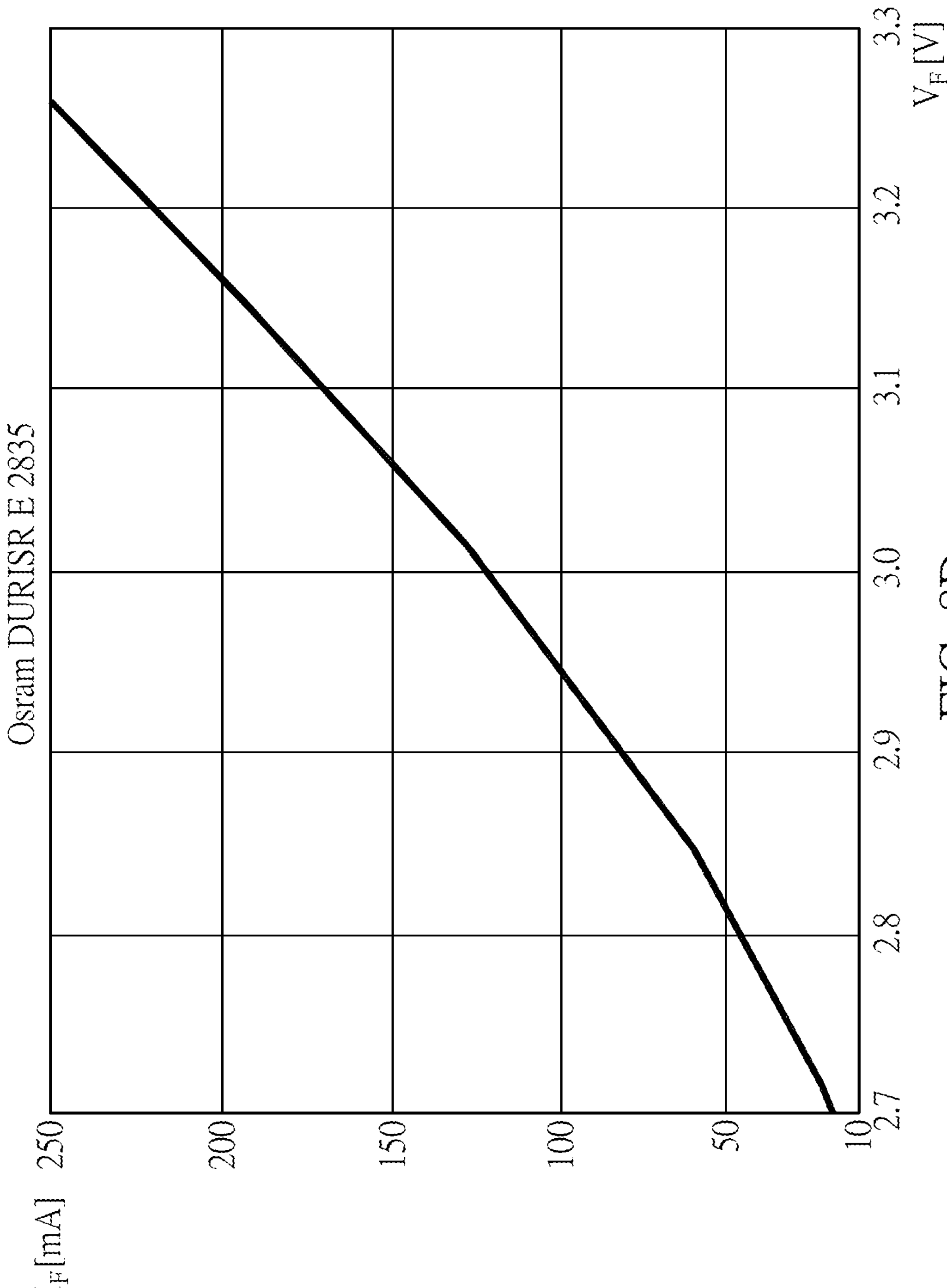

Osram DURISR E 2835
I_F [mA]
250
200
150
100
50
10
2.7
2.8
2.9
3.0
3.1
3.2
3.3
V_F [V]

FIG. 8D

Brand	V_F Min.	V_F Max.	Product Series	Information Source
CREE	2.9V	3.3V	J Series LEDs/J Series 2835	www.cree.com/led-components/products/j2835/jseries-2835
LUMILEDS	2.7V	3.3V	LUXEON 2835 Line	www.lumileds.com/luxeon2835line
SAMSUNG	2.9V	3.3V	KM281BA+	www.samsung.com/app/components/products/j2835/jseries-2835
OSRAM	2.7V	3.3V	DURIS® E/DURISR E 2835	www.osram.com/app/product_selector/#!?query=DORIS%20E%202835&sortField=&sortOrder=&start-0&filters=productbrand,DORIS,E&filters-productbrand,DORIS

FIG. 9

TWO-LEVEL LED SECURITY LIGHT WITH MOTION SENSOR

CROSS-REFERENCE TO RELATED APPLICATION

This is a continuation application of prior application Ser. No. 15/896,403, filed on 14 Feb. 2018, currently pending. Ser. No. 15/896,403 is a continuation application of prior application Ser. No. 15/785,658, filed on 17 Oct. 2017, currently pending. Ser. No. 15/785,658 is a continuation application of prior application Ser. No. 15/375,777 filed on 12 Dec. 2016, which issued as U.S. Pat. No. 9,826,590. U.S. Pat. No. 9,826,590 is a continuation application of prior application Ser. No. 14/836,000 filed on 26 Aug. 2015, which issued as U.S. Pat. No. 9,622,325, and which is a divisional application of Ser. No. 14/478,150, filed on 5 Sep. 2014, issued as U.S. Pat. No. 9,445,474, which is a continuation application of Ser. No. 13/222,090, filed 31 Aug. 2011, which issued as U.S. Pat. No. 8,866,392 on 21 Oct. 2014.

BACKGROUND OF THE INVENTION

1. Technical Field

The present disclosure relates to a lighting apparatus, in particular, to a two-level security LED light with motion sensor

2. Description of Related Art

Lighting sources such as the fluorescent lamps, the incandescent lamps, the halogen lamps, and the light-emitting diodes (LED) are commonly found in lighting apparatuses for illumination purpose. Photoresistors are often utilized in outdoor lighting applications for automatic illuminations, known as the Photo-Control (PC) mode. Timers may be used in the PC mode for turning off the illumination or for switching to a lower level illumination of a lighting source after the lighting source having delivered a high level illumination for a predetermined duration, referred as the Power-Saving (PS) mode. Motion sensors are often used in the lighting apparatus for delivering full-power illumination thereof for a short duration when a human motion is detected, then switching back to the PS mode. Illumination operation controls such as auto-illumination in accordance to the background brightness detection, illumination using timer, illumination operation control using motion sensing results (e.g., dark or low luminous power to fully illuminated), and brightness control are often implemented by complex circuitries. In particular, the design and construction of LED drivers are still of a complex technology with high fabrication cost.

Therefore, how to develop a simple and effective design method on illumination controls such as enhancing contrast in illumination and color temperature for various types lighting sources, especially the controls for LEDs are the topics of the present disclosure.

SUMMARY OF THE INVENTION

An exemplary embodiment of the present disclosure provides a two-level LED security light with motion sensor which may switch to high level illumination in the Power-Saving (PS) mode for a predetermined duration time when a human motion is detected thereby achieve warning pur-

pose using method of electric current or lighting load adjustment. Furthermore, prior to the detection of an intrusion, the LED security light may be constantly in the low level illumination to save energy.

An exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit further includes one or a plurality of series-connected LEDs; when the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a high level or a low level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit increases the electric current that flows through the light-emitting unit so as to generate the high level illumination for a predetermined duration.

Another exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, a light-emitting unit. The light-emitting unit includes a plurality of series-connected LEDs. When the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on a portion or all the LEDs of the light-emitting unit to generate a low level or a high level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off all the LEDs in the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit turns on a plurality of LEDs in the light-emitting unit and generates the high level illumination for a predetermine duration. An electric current control circuit is integrated in the exemplary embodiment for providing constant electric current to drive the LEDS in the light-emitting unit.

One exemplary embodiment of the present disclosure provides a two-level LED security light including a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes a phase controller and one or a plurality of parallel-connected alternating current (AC) LEDs. The phase controller is coupled between the described one or a plurality parallel-connected ACLEDs and AC power source. The loading and power control unit may through the phase controller control the average power of the light-emitting unit; when the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a high level or a lower level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects a human motion in the PS mode, the loading and power control unit increases the average power of the light-emitting unit thereby generates the high level illumination for a predetermine duration.

According to an exemplary embodiment of the present disclosure, a two-level LED security light includes a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes X high wattage

ACLEDs and Y low wattage ACLEDs connected in parallel. When the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on the plurality of low wattage ACLEDs to generate a low level illumination; when the light sensing control unit detects that the ambient light is higher than a predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensor detects an intrusion, the loading and power control unit turns on both the high wattage ACLEDs and the low wattage ACLEDs at same time thereby generates a high level illumination for a predetermine duration, wherein X and Y are of positive integers.

According to an exemplary embodiment of the present disclosure, a two-level LED security light with motion sensor includes a power supply unit, a light sensing control unit, a motion sensing unit, a loading and power control unit, and a light-emitting unit. The light-emitting unit includes a rectifier circuit connected between one or a plurality of parallel-connected AC lighting sources and AC power source. The loading and power control unit may through the rectifier circuit adjust the average power of the light-emitting unit. When the light sensing control unit detects that the ambient light is lower than a predetermined value, the loading and power control unit turns on the light-emitting unit to generate a low level illumination; when the light sensing control unit detects that the ambient light is higher than the predetermined value, the loading and power control unit turns off the light-emitting unit; when the motion sensing unit detects an intrusion, the loading and power control unit increases the average power of the light-emitting unit thereby generates a high level illumination for a predetermine duration. The rectifier circuit includes a switch parallel-connected with a diode, wherein the switch is controlled by the loading and power control unit.

To sum up, a two-level LED security light with motion sensor provided by an exemplary embodiment in the preset disclosure, may execute Photo-Control (PC) and Power-Saving (PS) modes. When operates in the PC mode, the lighting apparatus may auto-illuminate at night and auto-turnoff at dawn. The PC mode may generate a high level illumination for a predetermined duration then automatically switch to the PS mode by a control unit to generate a low level illumination. When the motion sensor detects a human motion, the disclosed LED security light may immediate switch to the high level illumination for a short predetermined duration thereby achieve illumination or warning effect. After the short predetermined duration, the LED security light may automatically return to the low level illumination for saving energy.

In order to further understand the techniques, means and effects of the present disclosure, the following detailed descriptions and appended drawings are hereby referred, such that, through which, the purposes, features and aspects of the present disclosure can be thoroughly and concretely appreciated; however, the appended drawings are merely provided for reference and illustration, without any intention to be used for limiting the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the present disclosure, and are incorporated in and constitute a part of this specification. The drawings illustrate exemplary embodiments of the present disclosure and, together with the description, serve to explain the principles of the present disclosure.

FIG. **1** schematically illustrates a block diagram of a two-level LED security light in accordance with an exemplary embodiment of the present disclosure.

FIG. **1**A is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for an AC LED two-level security light, wherein the loading and power comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises a bidirectional semiconductor switching device for controlling an average electric power to be delivered to the AC LED.

FIG. **1**B is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for a DC LED two-level security light, wherein the loading and power control unit comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises an unidirectional semiconductor switching device for controlling an average electric power to be delivered to the DC LED.

FIG. **1**C is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for a AC LED two-level security light including a first set having N number LEDs and a second set having M number LEDs, wherein the loading and power control unit comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises bidirectional semiconductor switching devices for controlling an average electric power to be delivered to the AC LED.

FIG. **1**D is an enhanced block diagrammed under FIG. **1** to specifically illustrate an embodiment of FIG. **1** for a DC LED two-level security light including a first set having N number LEDs and a second set having M number LEDs, wherein the loading and power control unit comprises a switching circuitry and a microcontroller, wherein the switching circuitry further comprises unidirectional semiconductor switching devices for controlling an average electric power to be delivered to the DC LED.

FIG. **2**A illustrates a schematic diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure.

FIG. **2**B graphically illustrates a timing waveform of a pulse width modulation (PWM) signal in accordance to the first exemplary embodiment of the present disclosure.

FIG. **3**A illustrates a schematic diagram of a two-level LED security light in accordance to the second exemplary embodiment of the present disclosure.

FIG. **3**B illustrates a schematic diagram of a two-level LED security light in accordance to the second exemplary embodiment of the present disclosure.

FIG. **4**A illustrates a schematic diagram of a two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **4**B illustrates a timing waveform of two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **5** illustrates a schematic diagram of a two-level LED security light in accordance to the third exemplary embodiment of the present disclosure.

FIG. **6** illustrates a schematic diagram of a two-level LED security light in accordance to the fourth exemplary embodiment of the present disclosure.

FIG. **7** illustrates a schematic diagram of a two-level LED security light in accordance to the fifth exemplary embodiment of the present disclosure.

FIGS. **8**A, **8**B, **8**C and **8**D schematically and respectively show I-V relationship charts (Forward Current vs. Forward Voltage) for a white LED chip from each of 4 different LED manufacturers.

FIG. 9 is a data sheet showing data of the minimum forward voltages and maximum forward voltages collected from various LED manufacturers.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Reference is made in detail to the exemplary embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or alike parts.

First Exemplary Embodiment

Refer to FIG. **1**, which schematically illustrates a block diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure. A two-level LED security light (herein as the lighting apparatus) **100** includes a power supply unit **110**, a light sensing control unit **120**, a motion sensing unit **130**, a loading and power control unit **140**, and a light-emitting unit **150**. The power supply unit **110** is used for supplying power required to operate the system, wherein the associated structure includes the known AC/DC voltage converter. The light sensing control unit **120** may be a photoresistor, which may be coupled to the loading and power control unit **140** for determining daytime or nighttime in accordance to the ambient light. The motion sensing unit **130** may be a passive infrared sensor (PIR), which is coupled to the loading and power control unit **140** and is used to detect intrusions. When a person is entering a predetermined detection zone of the motion sensing unit **130**, a sensing signal thereof may be transmitted to the loading and power control unit **140**.

The loading and power control unit **140** which is coupled to the light-emitting unit **150** may be implemented by a microcontroller. The loading and power control unit **140** may control the illumination levels of the light-emitting unit **150** in accordance to the sensing signal outputted by the light sensing control unit **120** and the motion sensing unit **130**. The light-emitting unit **150** may include a plurality of LEDs and switching components. The loading and power control unit **140** may control the light-emitting unit **150** to generate at least two levels of illumination variations.

When the light sensing control unit **120** detects that the ambient light is lower than a predetermined value (i.e., nighttime), the loading and power control unit **140** executes the Photo-Control (PC) mode by turning on the light-emitting unit **150** to generate a high level illumination for a predetermined duration then return to a low level illumination for Power-Saving (PS) mode. When the light sensing control unit **120** detects that the ambient light is higher than a predetermined value (i.e., dawn), the loading and power control unit **140** turns off the light-emitting unit **150**. In the PS mode, when the motion sensing unit **130** detects a human motion, the loading and power control unit **140** may increase the electric current which flow through the light-emitting unit **150**, to generate the high level illumination for a short predetermined duration. After the short predetermined duration, the loading and power control unit **140** may automatically lower the electric current that flow through the light-emitting unit **150** thus have the light-emitting unit **150** return to low level illumination for saving energy.

Refer to **2**A, which illustrates a schematic diagram of a two-level LED security light in accordance to the first exemplary embodiment of the present disclosure. The light sensing control unit **120** may be implemented by a light sensor **220**; the motion sensing unit **130** may be implemented by a motion sensor **230**; the loading and power control unit **140** may be implemented by a microcontroller **240**. The light-emitting unit **250** includes three series-connected LEDs L**1**~L**3**. The LEDs L**1**~L**3** is connected between a DC source and a transistor Q**1**, wherein the DC source may be provided by the power supply unit **110**. The transistor Q**1** may be an N-channel metal-oxide-semiconductor field-effect-transistor (NMOS). The transistor Q**1** is connected between the three series-connected LEDs L**1**~L**3** and a ground GND. The loading and power control unit **140** implemented by the microcontroller **240** may output a pulse width modulation (PWM) signal to the gate of transistor Q**1** to control the average electric current. It is worth to note that the electric components depicted in FIG. **2**A only serves as an illustration for the exemplary embodiment of the present disclose and hence the present disclosure is not limited thereto.

Refer to FIG. **2**B concurrently, which graphically illustrates a timing waveform of a pulse width modulation (PWM) signal in accordance to the first exemplary embodiment of the present disclosure. In the PC mode, the PWM signal may be used to configure the transistor Q**1** to have the conduction period T_{off} being longer than the cut-off period T_{off}. On the other hand in the PS mode, the PWM signal may configure the transistor Q**1** to have the conduction period T_{on} being shorter than the cut-off period T_{off}. In comparison of the illumination levels between the PC and PS modes, as the conduction period T_{on} of transistor Q**1** being longer under the PC mode, therefore have higher average electric current driving the light-emitting unit **250** thereby generate high illumination, which may be classified as the high level illumination; whereas as the conduction period T_{on} of transistor Q**1** is shorter in the PS mode, therefore have lower average electric current driving the light-emitting unit **250** thereby generate low illumination, which may be classified as the low level illumination.

The microcontroller **240** turns off the light-emitting unit **250** during the day and activates the PC mode at night by turning on the light-emitting unit **250** to generate the high level illumination for a short predetermined duration then return to the low level illumination thereby entering the PS mode. When the motion sensor **230** detects a human motion in the PS mode, the light-emitting unit **250** may switch to the high level illumination for illumination or warning application. The light-emitting unit **250** may return to the low level illumination after maintaining at the high level illumination for a short predetermined duration to save energy.

In addition, the microcontroller **240** is coupled to a time setting unit **260**, wherein the time setting unit **260** may allow the user to configure the predetermined duration associated with the high level illumination in the PC mode, however the present disclosure is not limited thereto. The time setting unit is a type of external control units designed to detect various external control signals and to convert the various external control signals into various message signals interpretable by the controller for setting various operating parameters of a security light including at least a time length setting for various illumination modes, a light intensity setting for various illumination modes and switching between illumination modes. The external control units may be configured with a push button, a touch sensor, a voltage divider, a power interruption detection circuitry or a wireless remote control receiver for generating message signals interpretable by the controller.

Second Exemplary Embodiment

Refer again to FIG. **1**, wherein the illumination variations of the light-emitting unit **150** may be implemented through

the number of light-source loads being turned on to generate more than two levels of illumination. The lighting apparatus **100** in the instant exemplary embodiment may be through turning on a portion of LEDs or all the LEDs to generate a low and a high level of illuminations.

Refer to FIG. **3**A concurrently, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the second exemplary embodiment of the present disclosure. The main difference between FIG. **3**A and FIG. **2**A is in the light-emitting unit **350**, having three series-connected LEDs L**1**~L**3** and NMOS transistors Q**1** and Q**2**. The LEDs L**1**~L**3** are series connected to the transistor Q**1** at same time connected between the DC source and a constant electric current control circuit **310**. Moreover, transistor Q**2** is parallel connected to the two ends associated with LEDs L**2** and L**3**. The gates of the transistors Q**1** and Q**2** are connected respectively to a pin PC and a pin PS of the microcontroller **240**. The constant electric current control circuit **310** in the instant exemplary embodiment maintains the electric current in the activated LED at a constant value, namely, the LEDs L**1**~L**3** are operated in constant-current mode.

Refer to FIG. **3**A, the pin PC of the microcontroller **240** controls the switching operations of the transistor Q**1**; when the voltage level of pin PC being either a high voltage or a low voltage, the transistor Q**1** may conduct or cut-off, respectively, to turn the LEDs L**1**~L**3** on or off. The pin PS of the microcontroller **240** controls the switch operations of the transistor Q**2**, to form two current paths **351** and **352** on the light-emitting unit **350**. When the voltage at the pin PS of the microcontroller **240** is high, the transistor Q**2** conducts, thereby forming the current path **351** passing through the LED L**1** and the transistor Q**2**; when the voltage at the pin PS being low, the transistor Q**2** cuts-off, thereby forming the current path **352** passing through all the LEDs L**1**~L**3**. The microcontroller **240** may then control the switching operation of the transistor Q**2** to turn on the desired number of LEDs so as to generate a high or a low level illumination.

When light sensor **220** detects that the ambient light is higher than a predetermined value, the microcontroller **240** through the pin PC outputs a low voltage, which causes the transistor Q**1** to cut-off and turns off all the LEDs L**1**~L**3** in the light-emitting unit **350**. Conversely, when the light sensor **220** detects that the ambient light is lower than the predetermined value, the microcontroller **240** activates the PC mode, i.e., outputting a high voltage from pin PC and a low voltage from pin PS, to activate the transistor Q**1** while cut-off the transistor Q**2**, thereby forming the current path **352**, to turn on the three LEDs L**1**~L**3** in the light-emitting unit **350** so as to generate the high level illumination for a predetermined duration. After the predetermined duration, the microcontroller **240** may switch to the PS mode by having the pin PC continue outputting a high voltage and the pin PS outputting a high voltage, to have the transistor Q**2** conducts, thereby forming the current path **351**. Consequently, only the LED L**1** is turned on and the low level illumination is generated.

When the motion sensor detects a human motion in the PS mode, the pin PS of the microcontroller **240** temporarily switches from the high voltage to a low voltage, to have the transistor Q**2** temporarily cuts-off thus forming the current path **352** to activate all the LEDs in the light-emitting unit **350**, thereby temporarily generates the high level illumination. The light-emitting unit **350** is driven by a constant electric current, therefore the illumination level generated thereof is directly proportional to the number of LEDs activated. FIG. **3**B illustrates another implementation for FIG. **3**A, wherein the relays J**1** and J**2** are used in place of NMOS transistors to serve as switches. The microcontroller **240** may control the relays J**2** and J**1** through regulating the switching operations of the NPN bipolar junction transistors Q**4** and Q**5**. Moreover, resistors R**16** and R**17** are current-limiting resistors.

In the PC mode, the relay J**1** being pull-in while the relay J**2** bounce off to have constant electric current driving all the LEDs L**1**~L**3** to generate the high level illumination; in PS mode, the relays J**1** and J**2** both pull-in to have constant electric current only driving the LED L**1** thus the low level illumination may be thereby generated. Furthermore, when the motion sensor **230** detects a human motion, the pin PS of the microcontroller **240** may temporarily switch from high voltage to low voltage, forcing the relay J**2** to temporarily bounce off and the relay J**1** pull-in so as to temporarily generate the high level illumination.

The LED L**1** may adopt a LED having color temperature of 2700K while the LEDs L**2** and L**3** may adopt LEDs having color temperature of 5000K in order to increase the contrast between the high level and the low level illuminations. The number of LEDs included in the light-emitting unit **350** may be more than three, for example five or six LEDs. The transistor Q**2** may be relatively parallel to the two ends associated with a plurality of LEDs to adjust the illumination difference between the high and the low illumination levels. Additionally, the light-emitting unit **350** may include a plurality of transistors Q**2**, which are respectively coupled to the two ends associated with each LED to provide more lighting variation selections. The microcontroller **240** may decide the number of LEDs to turn on in accordance to design needs at different conditions. Based on the explanation of the aforementioned exemplary embodiment, those skills in the art should be able to deduce other implementation and further descriptions are therefore omitted.

Third Exemplary Embodiment

Refer back to FIG. **1**, wherein the light-emitting unit **150** may include a phase controller and one or more parallel-connected alternating current (AC) LEDs. The phase controller is coupled between the described one or more parallel-connected ACLEDs and AC power source. The loading and power controller **140** in the instant exemplary embodiment may through the phase controller adjust the average power of the light-emitting unit **150** so as to generate variations in the low level and the high level illuminations.

Refer to FIG. **4**A, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the third exemplary embodiment of the present disclosure. The main difference between FIG. **4**A and FIG. **3** is in that the light-source load is an ACLED, which is coupled to the AC power source, and further the light-emitting unit **450** includes a phase controller **451**. The phase controller **451** includes a bi-directional switching device **452**, here, a triac, a zero-crossing detection circuit **453**, and a resistor R. The microcontroller **240** turns off the light-emitting unit **450** when the light sensor **220** detects that the ambient light is higher than a predetermined value. Conversely, when the light sensor **220** detects that the ambient light is lower than the predetermined value, the microcontroller **240** activates the PC mode by turning on the light-emitting unit **450**. In the PC mode, the microcontroller **240** may select a control pin for outputting a pulse signal which through a resistor R triggers the triac **452** to have a large conduction angle. The large conduction angle configures the light-emitting unit **450**

to generate a high level illumination for a predetermined duration. Then the microcontroller **240** outputs the pulse signal for PS mode through the same control pin to trigger the triac **452** to have a small conduction angle for switching the light-emitting unit **450** from the high level illumination to the low level illumination of the PS mode. Moreover, when the motion sensor **230** (also called motion sensing unit) detects a human motion in the PS mode, the microcontroller **240** temporarily outputs the PC-mode pulse signal through the same control pin to have the light-emitting unit **450** generated the high level illumination for a short predetermined duration. After the short predetermined duration, the light-emitting unit **450** returns to the low level illumination.

In the illumination control of the ACLED, the microcontroller **240** may utilize the detected zero-crossing time (e.g., the zero-crossing time of an AC voltage waveform) outputted from the zero-crossing detection circuit **453** to send an AC synchronized pulse signal thereof which may trigger the triac **452** of the phase controller **451** thereby to change the average power input to the light-emitting unit **450**. As the ACLED has a cut-in voltage V_t for start conducting, thus if the pulse signal inaccurately in time triggers the conduction of the triac **452**, then the instantaneous value of AC voltage may be lower than the cut-in voltage V_t of ACLED at the trigger pulse. Consequently, the ACLED may result in the phenomenon of either flashing or not turning on. Therefore, the pulse signal generated by the microcontroller **240** must fall in a proper time gap behind the zero-crossing point associated with the AC sinusoidal voltage waveform.

Supposing an AC power source having a voltage amplitude V_m and frequency f, then the zero-crossing time gap t_D of the trigger pulse outputted by the microcontroller **240** should be limited according to $t_o<t_D<½f^{-t}{}_o$ for a light-source load with a cut-in voltage V_t, wherein $t_o=(½\pi f)\sin^{-1}(V_t/V_m)$. The described criterion is applicable to all types of ACLEDs to assure that the triac **452** can be stably triggered in both positive and negative half cycle of the AC power source. Take ACLED with V_t (rms)=80V as an example, and supposing the V_m(rms)=110V and f=60 Hz, then t_o=2.2 ms and (½f)=8.3 ms may be obtained. Consequently, the proper zero-crossing time gap t_D associated with the phase modulation pulse outputted by the microcontroller **240** which lagged the AC sinusoidal voltage waveform should be designed in the range of 2.2 ms$<t_D<$6.1 ms.

Refer to FIG. **4**B, which illustrates a timing waveform of the two-level LED security light in accordance to the third exemplary embodiment of the present disclosure. Waveforms (a)~(d) of FIG. **4**B respectively represent the AC power source, the output of the zero-crossing detection circuit **453**, the zero-crossing delay pulse at the control pin of the microcontroller **240**, and the voltage waveform across the two ends of the ACLED in the light-emitting unit **450**. The zero-crossing detection circuit **453** converts the AC voltage sinusoidal waveform associated with the AC power source to a symmetric square waveform having a low and a high voltage levels as shown in FIG. **4**B(b). At the zero-crossing point of the AC voltage sinusoidal wave, the symmetric square waveform may transit either from the low voltage level to the high voltage level or from the high voltage level to the low voltage level. Or equivalently, the edge of the symmetric square waveform in the time domain corresponds to the zero-crossing point of the AC voltage sinusoidal waveform. As shown in FIG. **4**B(c), the microcontroller **240** outputs a zero-crossing delay pulse in correspondence to the zero-crossing point of the AC sinusoidal waveform in accordance to the output waveform of the zero-crossing detection circuit **453**. The zero-crossing delay pulse is relative to an edge of symmetric square waveform behind a time gap t_D in the time domain. The t_D should fall in a valid range, as described previously, to assure that the triac **452** can be stably triggered thereby to turn on the ACLED. FIG. **4**B(d) illustrates a voltage waveform applied across the two ends associated with the ACLED. The illumination level of the light-emitting unit **450** is related to the conduction period t_{on} of the ACLED, or equivalently, the length t_{on} is directly proportional to the average power inputted to the ACLED. The difference between the PC mode and the PS mode being that in the PC mode, the ACLED has longer conduction period, thereby generates the high level illumination; whereas in the PS mode, the ACLED conduction period is shorter, hence generates the low level illumination.

Refer to FIG. **5**, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the third exemplary embodiment of the present disclosure. The light-emitting unit **550** of the lighting apparatus **100** includes an ACLED**1**, an ACLED**2**, and a phase controller **551**. The phase controller **551** includes triacs **552** and **553**, the zero-crossing detection circuit **554** as well as resistors R**1** and R**2**. The light-emitting unit **550** of FIG. **5** is different from the light-emitting unit **450** of FIG. **4** in that the light-emitting unit **550** has more than one ACLEDs and more than one bi-directional switching devices. Furthermore, the color temperatures of the ACLED**1** and the ACLED**2** may be selected to be different.

In the exemplary embodiment of FIG. **5**, the ACLED**1** has a high color temperature, and the ACLED**2** has a low color temperature. In the PC mode, the microcontroller **240** uses the phase controller **551** to trigger both ACLED**1** and ACLED**2** to conduct for a long period, thereby to generate the high level illumination as well as illumination of mix color temperature. In the PS mode, the microcontroller **240** uses the phase controller **551** to trigger only the ACLED**2** to conduct for a short period, thereby generates the low level illumination as well as illumination of low color temperature. Moreover, in the PS mode, when the motion sensor **230** detects a human motion, the microcontroller **240** may through the phase controller **551** trigger the ACLED**1** and ACLED**2** to conduct for a long period. Thereby, it may render the light-emitting unit **450** to generate the high level illumination of high color temperature and to produce high contrast in illumination and hue, for a short predetermined duration to warn the intruder. Consequently, the lighting apparatus may generate the high level or the low level illumination of different hue. The rest of operation theories associated with the light-emitting unit **550** are essentially the same as the light-emitting unit **450** and further descriptions are therefore omitted.

Fourth Exemplary Embodiment

Refer to FIG. **6**, which illustrates a schematic diagram of a two-level LED security light **100** in accordance to the fourth exemplary embodiment of the present disclosure. The light-emitting unit **150** of FIG. **1** may be implemented by the light-emitting unit **650**, wherein the light-emitting unit **650** includes three ACLED**1~3** having identical luminous power as well as switches **651** and **652**. In which, switches **651** and **652** may be relays. The parallel-connected ACLED**1** and ACLED**2** are series-connected to the switch **652** to produce double luminous power, and of which the ACLED**3** is parallel connected to, to generate triple luminous power, and of which an AC power source is further coupled to through

the switch **651**. Moreover, the microcontroller **240** implements the loading and power control unit **140** of FIG. **1**. The pin PC and pin PS are respectively connected to switches **651** and **652** for outputting voltage signals to control the operations of switches **651** and **652** (i.e., open or close).

In the PC mode, the pin PC and pin PS of the microcontroller **240** control the switches **651** and **652** to be closed at same time. Consequently, the ACLED**1**~**3** are coupled to the AC power source and the light-emitting unit **650** may generate a high level illumination of triple luminous power. After a short predetermined duration, the microcontroller **240** returns to PS mode. In which the switch **651** is closed while the pin PS controls the switch **652** to be opened, consequently, only the ACLED**3** is connected to AC power source, and the light-emitting unit **650** may thus generate the low level illumination of one luminous power. In the PS mode, when the motion sensor **230** detects a human motion, the microcontroller **240** temporarily closes the switch **652** to generate high level illumination with triple luminous power for a predetermined duration. After the predetermined duration, the switch **652** returns to open status thereby to generate the low level illumination of one luminous power. The lighting apparatus of FIG. **6** may therefore through controlling switches **651** and **652** generate two level illuminations with illumination contrast of at least 3 to 1.

The ACLED**1** and ACLED**2** of FIG. **6** may be high power lighting sources having color temperature of 5000K. The ACLED**3** may be a low power lighting source having color temperature of 2700K. Consequently, the ACLED may generate two levels of illuminations with high illumination and hue contrast without using a zero-crossing detection circuit.

Fifth Exemplary Embodiment

Refer to FIG. **7**, which illustrates a schematic diagram of a two-level LED security light in accordance to the fifth exemplary embodiment of the present disclosure. The light-emitting unit **750** of FIG. **7** is different from the light-emitting unit **640** of FIG. **6** in that the ACLED**3** is series-connected to a circuit with a rectified diode D and a switch **753** parallel-connected together, and of which is further coupled through a switch **751** to AC power source. When the switch **753** closes, the AC electric current that passes through the ACLED**3** may be a full sinusoidal waveform. When the switch **753** opens, the rectified diode rectifies the AC power, thus only one half cycle of the AC electric current may pass through the ACLED, consequently the luminous power of ALCED**3** is cut to be half.

The pin PS of the microcontroller **240** synchronously controls the operations of switches **752** and **753**. If the three ACLED**1**~**3** have identical luminous power, then in the PC mode, the pin PC and pin PS of the microcontroller **240** synchronously close the switches **751**~**753** to render ACLED**1**~**3** illuminating, thus the light-emitting unit **750** generates a high level illumination which is three-times higher than the luminous power of a single ACLED. When in the PS mode, the microcontroller **240** closes the switch **751** while opens switches **752** and **753**. At this moment, only the ACLED**3** illuminates and as the AC power source is rectified by the rectified diode D, thus the luminous power of ACLED**3** is half of the AC power source prior to the rectification. The luminous power ratio between the high level and the low level illuminations is therefore 6 to 1. Consequently, strong illumination contrast may be generated to effectively warn the intruder.

It should be noted that the light-emitting unit in the fifth exemplary embodiment is not limited to utilizing ACLEDs. In other words, the light-emitting unit may include any AC lighting sources such as ACLEDs, incandescent lamps, or fluorescent lamps.

A lighting apparatus may be implemented by integrating a plurality of LEDs with a microcontroller and various types of sensor components in the controlling circuit in accordance to the above described five exemplary embodiments. This lighting apparatus may automatically generate high level illumination when the ambient light detected is insufficient and time-switch to the low level illumination. In addition, when a person is entering the predetermined detection zone, the lighting apparatus may switch from the low level illumination to the high level illumination, to provide the person with sufficient illumination or to generate strong illumination and hue contrast for monitoring the intruder.

When the light source of the light emitting unit **150** is confined to the use of an LED load, the compliance and satisfaction of a voltage operating constraint attributable to the unique electrical characteristics of the LED load is vital to a successful performance of an LED lighting device. Any LED lighting device failing to comply with the voltage operating constraint of the unique electrical characteristics is bound to become a trouble art. This is because the LED as a kind of solid state light source has completely different electrical characteristics for performing light emission compared with conventional light source such as incandescent bulbs or fluorescent bulbs. For instance, for a white light or blue light LED there exists a very narrow voltage domain ranging from a threshold voltage at 2.5 volts to a maximum working voltage at 3.3 volts, which allows to operate adequately and safely the LED; in other words, when a forward voltage imposed on the LED is lower than the threshold voltage, the LED is not conducted and therefore no light is emitted, when the forward voltage exceeds the maximum working voltage, the heat generated by a forward current could start damaging the construction of the LED. Therefore, the forward voltage imposed on the LED is required to operate between the threshold voltage and the maximum working voltage.

In respect to the LED load of the light-emitting unit **150**, the cut-in voltage V_t of ACLEDs is technically also referred to as the threshold voltage attributable to PN junctions manufactured in LEDs. More specifically, the LED is made with a PN junction semiconductor structure inherently featured with three unique electrical characteristics, the first characteristic is one-way electric conduction through the PN junction fabricated in the LED, the second electrical characteristic is the threshold voltage V_{th} required to trigger the LED to start emitting light and the third electrical characteristic is a maximum working voltage V_{max} allowed to impose on the LED to avoid a thermal runaway to damage or burn out the semiconductor construction of the LED. The described cut-in voltage V_t has the same meaning as the above mentioned threshold voltage V_{th} which is a more general term to be used for describing the second electrical characteristic of a PN junction semiconductor structure. Also because the cut-in voltage V_t is specifically tied to forming a formula to transform the threshold voltage into a corresponding time phase of AC power for lighting control, it is necessary to use the term V_{th} as a neutral word for describing the LED electrical characteristics to avoid being confused with the specific application for ACLED alone. Additionally, it is to be clarified that the term V_m is related to the amplitude of the instant maximum voltage of an AC

power source which has nothing to do with the third electrical characteristic V_{max} of an LED load.

An LED chip is a small piece of semiconductor material with at least one LED manufactured inside the semiconductor material. A plurality of LEDs may be manufactured and packaged inside an LED chip for different levels of wattage specification to meet different illumination need. For each LED chip designed with a different level of wattage specification there always exists a narrow voltage domain $V_{th}<V<V_{max}$, wherein V is a voltage across the LED chip, V_{th} is the threshold voltage to enable the LED chip to start emitting light and V_{max} is the maximum working voltage allowed to impose on the LED chip to protect the LED chip from being damaged or burned out by the heat generated by a higher working voltage exceeding V_{max}.

For an LED load configured with a plurality of the LED chips in any LED lighting device, regardless such LED load being configured with ACLED chips or DC LED chips, the working voltage V of each single LED chip is required to operate in a domain between a threshold voltage V_{th} and a maximum working voltage V_{max} or $V_{th}<V<V_{max}$ and the working voltage V_N of the LED load comprising N pieces of LED chips connected in series is therefore required to operate in a domain established by a threshold voltage of N times V_{th} ($N \times V_{th}$) and a maximum working voltage of N times V_{max} ($N \times V_{max}$) or $N \times V_{th}<V_N<N \times V_{max}$, wherein N is the number of the LED chips electrically connected in series. For any LED lighting device comprising an LED load it is required that the LED load in conjunction with an adequate level of power source is configured with a combination of in series and in parallel connections of LED chips such that the electric current passing through each LED chip of the LED load remains at an adequate level such that a voltage V across each LED chip complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED chip or a voltage V_N across the LED load configured with N number of LED chips connected in series complies with an operating constraint of $N \times V_{th}<V_N<N \times V_{max}$. Such narrow operating range therefore posts an engineering challenge for a circuit designer to successfully design an adequate level of power source and a reliable circuitry configured with an adequate combination of in series connection and in parallel connection of LED chips for operating a higher power LED security light.

FIGS. **8**A, **8**B, **8**C and **8**D comprises 4 drawings schematically and respectively showing a I-V relationship chart (Forward Current vs. Forward Voltage) for a white light LED chip from each of 4 different LED manufacturers; as can be seen from the chart when a forward voltage V is below a minimum forward voltage at around 2.5 volts, the LED chip is not conducted so the current I is zero, as the forward voltage exceeds 2.5 volts the LED chip is activated to generate a current flow to emit light, as the forward voltage continues to increase, the current I increases exponentially at a much faster pace, at a maximum forward voltage around 3.3 volts the current I becomes 250 mA which generates a heat that could start damaging the PN junction of the LED chip. The minimum forward voltage, i.e., the threshold voltage or the cut-in voltage, and the maximum forward voltage are readily available in the specification sheets at each of LED manufacturers, such as Cree, Lumileds, Samsung, Osram, and etc. Different LED manufacturers may have slightly different figures due to manufacturing process but the deviations of differences are negligible. The constraints of minimum forward voltage and maximum forward voltage represent physical properties inherent in any solid state light source. They are necessary matter for configuring any LED lighting products to ensure a normal performance of an LED load.

FIG. **9** is a data sheet showing data of the minimum forward voltages and maximum forward voltages collected from various LED manufacturers. They are fundamental requirements for configuring any LED lighting control devices to ensure a successful performance of any LED lighting device.

In summary, the compliance of voltage operating constraint $V_{th}<V<V_{max}$ featuring electrical characteristics of an LED chip is a critical technology for ensuring a normal performance of the LED load. Failing to comply with such voltage operating constraint can quickly age or seriously damage the semiconductor structure of the LED chip with a consequence of quick lumens depreciation of the LED bulbs and the product lifetime being substantially shortened, which will be unacceptable to the consumers. The compliance of the operating constraint $V_{th}<V<V_{max}$ is a necessary matter for any LED lighting device though it is not an obvious matter as it requires complicated technologies to calculate and coordinate among an adequate level of power source, a control circuitry and a non-linear light emitting load. For conventional lighting load such as incandescent bulb there exists no such operating constraint. This is why in the past years there had been many consumers complaining about malfunction of LED bulbs that the consumers were frustrated with the fast depreciation of lumens output and substantially shortened product lifetime of the LED bulbs purchased and used. A good example was a law suit case filed by the Federal Trade Commission on Sep. 7, 2010 (Case No. SACV10-01333 JVS) for a complaint against a leading lighting manufacturer for marketing deceptive LED lamps and making false claims with respect to the life time of their LED lamps and a huge amount of monetary relief was claimed with the Court in the complaint.

The present disclosure of a two-level LED security light provides a unique life-style lighting solution. The motivation of creating such life-style lighting solution has less to do with the energy saving aspect of the low level illumination mode because an LED is already a very energy saving light source compared with the conventional incandescent light source. For instance, a 10-watt LED security light when operated at a low level at 30% illumination it only saves 7 watts, which is not as significant as a 100-watt incandescent bulb which can save as much as 70 watts when operated at 30% illumination for a low level mode. While it is always good to save some extra energy, it is however not the main incentives for developing the present invention; the life-style lighting solution of the present disclosure is featured with two innovations which meaningfully improve the exquisite tastes of living in the evening, the first innovation is the creation of an aesthetic scene for the outdoor living environment, wherein at dusk the LED security light is automatically turned on by the photo sensor to perform the low level illumination with a low color temperature which is necessary for creating a soft and aesthetic night scene for the outdoor living area (such soft and aesthetic night view is not achievable by the high level illumination however), the second innovation is the creation of a navigation capacity similar to a light house effect for guiding people to safely move toward a destination in the outdoor living area without getting lost or encountering an accident, wherein when a motion intrusion is detected by the motion sensor the security light is instantly changed to perform a high level illumination mode with a high color temperature light which offers people a high visibility of the surrounding environment when needed. For the visibility of a surrounding

environment the high color temperature light is the winner while for the creation of a soft and aesthetic night view there is no substitute for the low color temperature light. It is the innovation of the present invention to configure a life-style security light with a low color temperature LED load and a high color temperature LED load respectively activated by a photo sensor and a motion sensor to resemble the natural phenomenon of a sun light. These two innovative functions ideally implemented by the LED loads coupled with the motion sensor to increase illumination with a high visibility when people enters into the short detection area make the present invention a perfect life-style lighting solution for enjoying an exquisite taste of evening life.

The above-mentioned descriptions represent merely the exemplary embodiment of the present disclosure, without any intention to limit the scope of the present disclosure thereto. Various equivalent changes, alternations or modifications based on the claims of present disclosure are all consequently viewed as being embraced by the scope of the present disclosure.

What is claimed is:

1. A lifestyle two-level LED security light comprising:

a light-emitting unit configured with an LED load;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit; and

a power supply unit;

wherein the LED load of the light-emitting unit includes a plurality of LEDs divided into two sets with a first set of N number LEDs and a second set of M number LEDs, wherein N and M are positive integers;

wherein the loading and power control unit includes a controller electrically coupled to the light sensing control unit, the motion sensing unit and at least two switching devices including at least a first switching device and a second switching device;

wherein the first switching device and the second switching device are electrically connected with the first set of N number LEDs and the second set of M number LEDs, wherein the first switching device and the second switching device are controlled by the controller to be conducting or cut-off to perform at least a first switching mode and a second switching mode;

wherein in the first switching mode the power supply unit drives at least the first set of N number LEDs to perform a low level illumination with a low light intensity and in the second switching mode the power supply unit drives at least the second set of M number LEDs to perform a high level illumination with a high light intensity;

wherein when an ambient light detected by the light sensing control unit is lower than a predetermined value, the loading and power control unit manages to turn on the first set of N number LEDs in the light-emitting unit to generate the low level illumination;

wherein when the ambient light detected by the light sensing control unit is higher than the predetermined value, the light-emitting unit is switched off;

wherein when a motion intrusion is detected by the motion sensing unit, the loading and power control unit manages to turn on at least the second set of M number LEDs to generate the high level illumination for a predetermined duration before resuming to the low level illumination; wherein the controller comprises at least a programmable integrated circuit device or an application specific integrated circuit, and wherein the plurality of LEDs of the first set of N number LEDs and the second set of M number LEDs in conjunction with a power level setting of the power supply unit are respectively designed with a configuration of in series and/or in parallel connections of LEDs such that an electric current passing through each LED of the light-emitting unit remains at an adequate level, and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of an LED; wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum operating voltage across each LED to avoid a thermal damage to LED construction.

2. The lifestyle two-level LED security light according to claim **1**, wherein when the second set of M number LEDs is turned on upon detecting the motion intrusion, the loading and power control unit continues to turn on the first set of N number LEDs.

3. The lifestyle two-level LED security light according to claim **1**, wherein when the second set of M number LEDs is turned on upon detecting the motion intrusion, the loading and power control unit manages to turn off the first set of N number LEDs.

4. The lifestyle two-level LED security light according to claim **1**, wherein a total wattage of the M number LEDs is greater than a total wattage of the N number LEDs.

5. The lifestyle two-level LED security light according to claim **1**, wherein a total wattage of the M number LEDs is equal to a total wattage of the N number LEDs.

6. The lifestyle two-level LED security light according to claim **1**, wherein the power supply unit outputs a DC power for operating the two-level LED security light, wherein the first set of N number LEDs and the second set of M number LEDs are connected in series, wherein a constant current control circuit is connected in series with the light-emitting unit such that an electric current level remains stable in light of a drastic change of lighting load between driving the N number LEDs for generating the low level illumination and driving at least the M number LEDs for generating the high level illumination.

7. The lifestyle two-level LED security light according to claim **6**, wherein when the two-level LED security is operated to generate the low level illumination, the low light intensity is further adjustable by the controller; wherein the first set of N number LEDs is configured to include a plurality of switching devices electrically coupled to the first set of N number LEDs and to the controller, wherein the controller is configured to control the number of LEDs to be turned on in the N number LEDs through bypassing unwanted LEDs in the N number LEDs respectively with the associated switching device(s) according to an external control signal played by a user or according to a value of a voltage divider set by the user.

8. The lifestyle two-level LED security light according to claim **6**, wherein when the two-level LED security is operated to generate the high level illumination, the high light intensity is further adjustable by the controller, wherein the second set of M number LEDs is configured to include a plurality of switching devices electrically coupled to the second set of M number LEDs and to the controller, wherein the controller is configured to control the number of LEDs to be turned on in the M number LEDs through bypassing unwanted LEDs in the M number LEDs with the associated switching device(s) according to an external control signal played by a user or according to a value of a voltage divider set by the user.

9. The lifestyle two-level LED security light according to claim **1**, wherein the power supply unit outputs at least one

DC power for operating the two-level LED security light; wherein the first set of N number LEDs and the second set of M number LEDs are connected in parallel, wherein the first switching device is electrically connected in series between the first set of N number LEDs and the power supply unit, wherein the second switching device is electrically connected in series between the second set of M number LEDs and the power supply unit.

10. The lifestyle two-level LED security light according to claim **9**, wherein when the two-level LED security light is operated to generate the low level illumination, the low light intensity of the low level illumination is further adjustable by the controller; wherein the controller in response to an external control signal played by a user outputs a PWM signal to control a time length of conduction period of the first switching device in each duty cycle such that an average electric current proportional to the time length of the conduction period is delivered to the light-emitting unit for performing a dimming work of the low level illumination mode.

11. The lifestyle two-level LED security light according to claim **9**, wherein when the two-level LED security light is operated to generate the high level illumination, the high light intensity of the high level illumination is further adjustable by the controller; wherein the controller in response to an external control signal played by a user outputs at least a PWM signal to control a time length of conduction period of at least the second switching device in each duty cycle such that an average electric current proportional to the time length of the conduction period is delivered to the light-emitting unit for performing a dimming work of the high level illumination mode.

12. The lifestyle two-level LED security light according to claim **9**, wherein when the two-level LED security light is operated to generate the high level illumination, the high light intensity of the high level illumination is further adjustable by the controller; wherein the controller in response to an external control signal played by a user outputs PWM signals to control time lengths of conduction periods of both the first switching device and the second switching device in each duty cycle such that average electric currents proportional to the time lengths of the conduction periods are delivered to the light-emitting unit for performing a dimming work of the high level illumination mode.

13. The lifestyle two-level LED security light according to claim **1**, wherein when each of the first set of N number LEDs and the second set of M number LEDs is configured with a plurality of LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series, a working voltage across each of the first set of N number LEDs and the second set of M number LEDs is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series.

14. The lifestyle two-level LED security light according to claim **13**, wherein the LED has the voltage V across each LED complying with an operating constraint of 2.5 volts $<V_{th}<V<V_{max}<$3.5 volts and the first set of N number LEDs and the second set of M number LEDs are required to operate with respective operating voltages V_N and V_M confined in domains expressed by $N_S\times2.5$ volts $<V_N<N_S\times3.5$ volts and $M_S\times2.5$ volts $<V_M<M_S\times3.5$ volts, with N_S and M_S respectively denoting the numbers of series connected LEDs in the first set of N number LEDs and the second set of M number LEDs, wherein $N_S\leq N$ and $M_S\leq M$.

15. A lifestyle two-level LED security light comprising:

a light-emitting unit configured with an LED load;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit; and

a power supply unit;

wherein the LED load of the light-emitting unit includes a plurality of LEDs divided into two sets with a first set of N number LEDs and a second set of M number LEDs, wherein N and M are positive integers; wherein the first set of N number LEDs and the second set of M number LEDs are covered by a light diffuser to create a diffused light;

wherein the loading and power control unit includes a controller electrically coupled to the light sensing control unit, the motion sensing unit and at least two switching devices including a first switching device and a second switching device;

wherein the first switching device and the second switching device are connected with the first set of N number LEDs and the second set of M number LEDs;

wherein the two switching devices are controlled by the controller to be respectively conducting or cut-off to perform at least a first switching mode and a second switching mode;

wherein in the first switching mode at least the first set of N number LEDs is turned on to perform a low level illumination with a low light intensity and in the second switching mode at least the second set of M number LEDs is turned on to perform a high level illumination with a high light intensity;

wherein when an ambient light detected by the light sensing control unit is lower than a predetermined value, the loading and power control unit manages to turn on at least the first set of N number LEDs in the light-emitting unit to generate the low level illumination;

wherein when the ambient light detected by the light sensing control unit is higher than the predetermined value, the LED load is switched off;

wherein when a motion intrusion is detected by the motion sensing unit, the loading and power control unit manages to turn on at least the second set of M number LEDs in the light-emitting unit to generate the high level illumination for a predetermined duration; and

wherein the N number LEDs emit light with a low color temperature to produce a soft and warm light to feature an aesthetic night view around the living area both for indoor and outdoor need while at the same time create a navigation capacity similar to a light house to help people move to a destination without getting lost or encountering an accident, wherein the M number LEDs emit light with a high color temperature to produce a much brighter light with a dual effect of security alert by means of creating drastic changes in both light intensity from low to high and light color temperature from warm to cool upon detecting a motion intrusion, wherein the high level illumination with the high color temperature enables people to have a high visibility of the surrounding environment when needed; and wherein the plurality of LEDs of the first set of N number LEDs and the second set of M number LEDs in conjunction with a power level setting of the power supply unit are respectively designed with a configu-

ration of in series and/or in parallel connections of LEDs such that an electric current passing through each LED of the light-emitting unit remains at an adequate level, and a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of an LED; wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum operating voltage across each LED to avoid a thermal damage to LED construction.

16. The lifestyle two-level LED security light according to claim **15**, wherein when the second set of M number LEDs is turned on upon detecting the motion intrusion, the loading and power control unit continues to turn on the first set of N number LEDs.

17. The lifestyle two-level LED security light according to claim **15**, wherein when the second set of M number LEDs is turned on upon detecting the motion intrusion, the loading and power control unit manages to turn off the first set of N number LEDs.

18. The lifestyle two-level LED security light according to claim **15**, wherein a total wattage of the M number LEDs is greater than a total wattage of the N number LEDs.

19. The lifestyle two-level LED security light according to claim **15**, wherein a total wattage of the M number LEDs is equal to a total wattage of the N number LEDs.

20. The lifestyle two-level LED security light according to claim **15**, wherein the power supply unit outputs a DC power for operating the lifestyle two-level LED security light, wherein the first set of N number LEDs and the second set of M number LEDs are connected in series, wherein a constant current control circuit is connected in series with the light-emitting unit such that an electric current level remains stable in light of a drastic change of lighting load between driving the N number LEDs for generating the low level illumination and driving at least the M number LEDs for generating the high level illumination.

21. The lifestyle two-level LED security light according to claim **20**, wherein when the lifestyle two-level LED security is operated to generate the low level illumination, the low light intensity is further adjustable by the controller; wherein the first set of N number LEDs is configured to include a plurality of switching devices electrically coupled to the first set of N number LEDs and to the controller, wherein the controller is configured to control the number of LEDs to be turned on in the N number LEDs through bypassing unwanted LEDs in the N number LEDs with the associated switching device(s) according to an external control signal played by a user or according to a value of a voltage divider set by the user.

22. The lifestyle two-level LED security light according to claim **20**, wherein when the two-level LED security is operated to generate the high level illumination, the high light intensity is further adjustable by the controller, wherein the second set of M number LEDs is configured to include a plurality of switching devices electrically coupled to the second set of M number LEDs and to the controller, wherein the controller is configured to control the number of LEDs to be turned on in the M number LEDs through bypassing unwanted LEDs in the M number LEDs with the associated switching device(s) according to an external control signal played by a user or according to a value of a voltage divider set by the user.

23. The lifestyle two-level LED security light according to claim **15**, wherein the power supply unit outputs at least one DC power for operating the two-level LED security light; wherein the first set of N number LEDs and the second set of M number LEDs are connected in parallel, wherein the first switching device is electrically connected in series between the first set of N number LEDs and the power supply unit, wherein the second switching device is electrically connected in series between the second set of M number LEDs and the power supply unit.

24. The lifestyle two-level LED security light according to claim **23**, wherein when the lifestyle two-level LED security light is operated to generate the low level illumination, the low light intensity of the low level illumination is further adjustable by the controller; wherein the controller in response to an external control signal played by a user outputs at least a PWM signal to control a time length of conduction period of at least the first switching device in each duty cycle such that an average electric current proportional to the time length of the conduction period is delivered to the light-emitting unit for performing a dimming work of the low level illumination.

25. The lifestyle two-level LED security light according to claim **23**, wherein when the lifestyle two-level LED security light is operated to generate the high level illumination, the high light intensity of the high level illumination is further adjustable by the controller; wherein the controller in response to an external control signal played by a user outputs at least a PWM signal to control a time length of conduction period of at least the second switching device in each duty cycle such that an average electric current proportional to the time length of the conduction period is delivered to the light-emitting unit for performing a dimming work of the high level illumination.

26. The lifestyle two-level LED security light according to claim **23**, wherein when the lifestyle two-level LED security light is operated to generate the high level illumination, the high light intensity of the high level illumination is further adjustable by the controller; wherein the controller in response to an external control signal played by a user outputs PWM signals to control time lengths of conduction period of both the first switching device and the second switching device in each duty cycle such that average electric currents proportional to the time lengths of the conduction period are delivered to the light-emitting unit for performing a dimming work of the high level illumination.

27. The lifestyle two-level LED security light according to claim **23**, wherein when the lifestyle two-level LED security light is operated to generate the high level illumination, the high light intensity of the high level illumination is further adjustable by the controller, wherein the controller in response to the external control signal outputs PWM signals to control time lengths of conduction periods of both the first switching device and the second switching device varying with the same pace in a range for adjusting the high light intensity of the high level illumination.

28. The lifestyle two-level LED security light according to claim **23**, wherein when the lifestyle two-level LED security light is operated to generate the low level illumination, a light color temperature of the low level illumination is further adjustable by the controller, wherein the controller in response to the external control signal outputs PWM signals to control time lengths of conduction periods of the first switching device and the second switching device to vary in a reverse manner such that a light intensity of the first set of N number LEDs with the low color temperature and a light intensity of the second set of M number LEDs with the high color temperature are reversely adjusted with the same pace to produce a variable mingled color temperature thru a light diffuser for performing a color temperature tuning of the low level illumination.

29. The lifestyle two-level LED security light according to claim 23, wherein when the lifestyle two-level LED security light is operated to generate the high level illumination, a light color temperature of the high level illumination is further adjustable by the controller, wherein the controller in response to the external control signal outputs PWM signals to control time lengths of conduction periods of the first switching device and the second switching device to vary in a reverse manner such that a light intensity of the first set of N number LEDs with the low color temperature and a light intensity of the second set of M number LEDs with the high color temperature are reversely adjusted with the same pace to produce a variable mingled color temperature thru a light diffuser for performing a color temperature tuning of the high level illumination.

30. The lifestyle two-level LED security light according to claim 23, wherein when the N number LEDs and the M number LEDs are both in conduction state, a light intensity of the N number LEDs and a light intensity of the M number LEDs are respectively adjustable, wherein the controller in response to an external control signal played by a user outputs a first PWM signal to control a first conduction rate of the first switching device and a second PWM signal to control a second conduction rate of the second switching device with an arrangement that the first conduction rate of the first switching device and the second conduction rate of the second switching device are reversely adjusted with the same pace such that a total electric power level transmitted to the N number LEDs and the M number LEDs is maintained at a constant level while a mingled color temperature of the light emitted by the N number LEDs and the light emitted by the M number LEDs thru a light diffuser is proportionately adjusted according to the external control signal to perform a color temperature tuning mode.

31. The lifestyle two-level LED security light according to claim 23, wherein when the N number LEDs and the M number LEDs are both in conduction state, a light intensity of the N number LEDs and a light intensity of the M number LEDs are respectively adjustable, wherein the controller in response to an external control signal played by an user outputs a first PWM signal to control a first conduction rate of the first switching device and a second PWM signal to control a second conduction rate of the second switching device with an arrangement that the first conduction rate of the first switching device and the second conduction rate of the second switching device are unidirectionally and proportionally adjusted with the same pace such that a mingled color temperature of the light emitted by the N number LEDs and the light emitted by the M number LEDs thru a light diffuser is maintained at a constant level while a light intensity of the light-emitting unit is being proportionately adjusted according to the external control signal to perform a dimming mode.

32. The lifestyle two-level LED security light according to claim 23, wherein when the N number LEDs and the M number LEDs are in conduction state, light intensity and light color temperature are both adjustable for performing a dimming and color temperature tuning control mode, wherein the controller in response to an external control signal played by a user outputs a second PWM signal to control a second conduction rate of the second switching device such that the M number LEDs with the high color temperature are dimmed according to the external control signal, wherein the controller manages to output a first PWM signal to control a first conduction state of the first switching device such that the N number LEDs with the low color temperature operates a constant power while the M number LEDs are being dimmed to create a dim to warm effect, wherein during a cycle of the dimming and color temperature tuning control mode, a light intensity and a light color temperature of the light-emitting unit are jointly determined by the external control signal.

33. The lifestyle two-level LED security light according to claim 32, wherein when the M number LEDs are dimmed to a cutoff state, the controller operates to change the first PWM signal to continuously reduce the first conduction rate of the first switching device such that the light intensity of the light-emitting unit continues to decrease with the low color temperature.

34. The lifestyle two-level LED security light according to claim 23, wherein when the N number LEDs and the M number LEDs are in conduction state, light intensity and light color temperature are both adjustable for performing a dimming and color temperature tuning control mode, wherein the controller in response to an external control signal outputs a first PWM signal to control a first conduction rate of the first switching device and a second PWM signal to control a second conduction rate of the second switching device, wherein the first PWM signal and the second PWM signal are configured to operate with an arrangement that the M number LEDs and the N number LEDs are respectively dimmed in such a way that the M number LEDs leads the N number LEDs in reaching a turned off state in performing the dimming and color temperature tuning control mode such that a mingled color temperature of the light emitted by the N number LEDs and the light emitted by the M number LEDs continues to change to a warmer illumination along with a continuous reduction of light intensity to create a dim to warm effect according to the external control signal, wherein during a cycle of the dimming and color temperature turning control mode, a light intensity and a light color temperature of the light-emitting unit are jointly determined by the external control signal.

35. The lifestyle two-level LED security light according to claim 23, wherein when the N number LEDs and the M number LEDs are in conduction state, a light intensity and a light color temperature are both adjustable for performing a dimming and color temperature tuning control mode, wherein the controller in response to an external control signal outputs a first PWM signal to control a first conduction rate of the first switching device and a second PWM signal to control a second conduction rate of the second switching device, wherein the first PWM signal and the second PWM signal are configured to operate with an arrangement that the M number LEDs and the N number LEDs are respectively dimmed in such a way that the M number LEDs leads the N number LEDs in reaching a turned off state; wherein in order to accelerate color temperature tuning pace along with a continuous reduction of light intensity, the first PWM signal initially manages to increase the conduction rate of the first switching device with a pace slower than the reduction pace of the conduction rate of the second switching device such that a mingled color temperature continues to change to a warmer illumination at a faster pace to perform a faster dim to warm process, wherein when a dim to warm process ceases at a time point when the M number LEDs reaches a turned off state is an inflection time point, the first PWM signal to reversely manage to decrease the conduction rate of the first switching device till the N number LEDs reaching the turned off state in performing the dimming and color temperature tuning control mode such that a mingled color temperature of the light emitted by the N number LEDs and the light emitted by the M number LEDs continues to change to a warmer illumination along

with a continuous reduction of light intensity to create a dim to warm effect according to the external control signal, wherein during a cycle of the dimming and color temperature turning control mode, a light intensity and a light color temperature of the light-emitting unit are jointly determined by the external control signal.

36. The lifestyle two-level LED security light according to claim **15**, wherein when each of the first set of N number LEDs and the second set of M number LEDs is configured with a plurality of LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series, a working voltage across each of the first set of N number LEDs and the second set of the M number LEDs is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series.

37. The lifestyle two-level LED security light according to claim **36**, wherein the LED has the voltage V across each LED complying with an operating constraint of 2.5 volts $<V_{th}<V<V_{max}<$3.5 volts and the first set of N number LEDs and the second set of M number LEDs are required to operate with respective operating voltages V_N and V_M confined in domains expressed by $N_S\times2.5$ volts $<V_N<N_S\times3.5$ volts and $M_S\times2.5$ volts $<V_M<M_S\times3.5$ volts, with N_S and M_S respectively denoting the numbers of series connected LEDs in the first set of N number LEDs and the second set of M number LEDs, wherein $N_S\leq N$ and $M_S\leq M$.

38. A two-level LED security light comprising:

a light-emitting unit;

a loading and power control unit;

a light sensing control unit;

a power supply unit; and

at least one external control unit;

wherein the light-emitting unit comprises a plurality of LEDs divided into two sets of LEDs with a first set of N number LEDs emitting light with a low color temperature and a second set of M number LEDs emitting light with a high color temperature, wherein N and M are positive integers; wherein the first set of N number LEDs and the second set of M number LEDs are covered by a light diffuser to create a diffused light;

wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the controller is electrically coupled to the light sensing control unit, the switching circuitry and the at least one external control unit;

wherein the switching circuitry is electrically coupled between at least one power source of the power supply unit and the light-emitting unit;

wherein the switching circuitry is controlled by the controller to perform at least respectively a first switching mode and a second switching mode according to signals respectively received from the light sensing control unit and the at least one external control unit;

wherein in the first switching mode at least the first set of the light-emitting unit is turned on to perform a first illumination mode and in the second switching mode at least the second set of the light-emitting unit is turned on to perform a second illumination mode;

wherein when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit manages to perform at least one of the first illumination mode and the second illumination mode;

wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the loading and power control unit manages to turn off all the LEDs in the light-emitting unit;

wherein the at least one external control unit is electrically coupled to the controller for adjusting at least one operating parameter of a light intensity of the first illumination mode or a light intensity of the second illumination mode or for switching from the first illumination mode to the second illumination mode; and

wherein the N number LEDs of the first set of the light-emitting unit and the M number LEDs of the second set of the light-emitting unit are respectively designed with a configuration of in series and/or in parallel connections such that when incorporated with a power level setting of the power supply unit an electric current passing through each LED of the M number LEDs and each LED of the N number LEDs remains at an adequate level such that a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of a LED, where V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across the LED to avoid a thermal damage or burning out of LED construction.

39. The two-level LED security light according to claim **38**, wherein when each of the first set of N number LEDs and the second set of M number LEDs is configured with a plurality of LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series, a working voltage across each of the first set of N number LEDs and the second set of M number LEDs is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series.

40. The two-level LED security light according to claim **39**, wherein the LED has the voltage V across each LED complying with an operating constraint of 2.5 volts $<V_{th}<V<V_{max}<$3.5 volts and the first set of N number LEDs and the second set of M number LEDs are required to operate with respective operating voltages V_N and V_M confined in domains expressed by $N_S\times2.5$ volts $<V_N<N_S\times3.5$ volts and $M_S\times2.5$ volts $<V_M<M_S\times3.5$ volts, with N_S and M_S respectively denoting the numbers of series connected LEDs in the first set of N number LEDs and the second set of M number LEDs, wherein $N_S\leq N$ and $M_S\leq M$.

41. The two-level LED security light according to claim **38**, wherein the at least one external control unit is a power interruption detection circuitry electrically coupled to the controller for detecting a short power interruption signal; wherein when the short power interruption signal is detected, the controller operates to alternately perform one of the first illumination mode and the second illumination mode; wherein the first illumination mode is a low level illumination mode with the low color temperature and the second illumination mode is a high level illumination mode with the high color temperature.

42. The two-level LED security light according to claim **38**, wherein the at least one external control unit is a power interruption detection circuitry electrically coupled to the controller for detecting a short power interruption signal;

wherein when the short power interruption signal is detected, the controller operates to alternately perform at least one of a first illumination mode, a second illumination mode and a third illumination mode; wherein when the first illumination mode is performed, the loading and power control unit manages to turn on only the first set of the light-emitting unit, wherein when the second illumination mode is performed, the loading and power control unit manages to turn on only the second set of the light-emitting unit, wherein when the third illumination mode is performed, the loading and power control unit manages to turn on the first set of the light-emitting unit with a reduced illumination by decreasing an electric power delivered to the first set of the light-emitting unit.

43. The two-level LED security light according to claim **38**, wherein the at least one external control unit is a power interruption detection circuitry electrically coupled to the controller for detecting a short power interruption signal; wherein when the short power interruption signal is detected, the controller operates to alternately perform at least one of a first illumination mode, a second illumination mode and a third illumination mode; wherein when the first illumination mode is performed, the loading and power control unit manages to turn on only the first set of the light-emitting unit to perform the low level illumination mode emitting light with the low color temperature, wherein when the second illumination mode is performed, the loading and power control unit manages to turn on only the second set of the light-emitting unit to perform the high level illumination mode emitting light with the high color temperature; wherein when the third illumination mode is performed, the loading and power control unit manages to reduce a first light intensity of the first set of the light-emitting unit and a second light intensity of the second set of the light-emitting unit respectively with the same pace such that the light-emitting unit accordingly performs a medium mingled color temperature.

44. A two-level LED security light comprising:

a light-emitting unit configured with at least a first LED load for emitting light with a low color temperature and at least a second LED load for emitting light with a high color temperature;

a diffuser covering the first LED load and the second LED load to create a diffused light with a mingled color temperature;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit;

a power supply unit; and

at least one external control unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the controller is electrically and respectively coupled with the light sensing control unit, the motion sensing unit, the switching circuitry and the at least one external control unit;

wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the light-emitting unit, wherein the power source is a DC power source configured in the power supply unit;

wherein the switching circuitry comprises at least one semiconductor switching device;

wherein the first LED load and the second LED load are connected in parallel and are further respectively and electrically coupled to the switching circuitry;

wherein the controller outputs control signals to control different conduction rates of the switching circuitry for delivering different electric powers from the power source respectively to the first LED load and the second LED load of the light emitting unit such that the light-emitting unit respectively generates illuminations of different light intensities and different mingled color temperatures for performing different illumination modes according to signals respectively received from the light sensing control unit, the motion sensing unit and the at least one external control unit;

wherein when an ambient light detected by the light sensing control unit is lower than a first predetermined value, at least the first LED load is switched on;

wherein the controller outputs at least a first control signal to control at least a first conduction rate of the switching circuitry such that a low electric power is delivered to the light-emitting unit to perform a low level illumination mode emitting light with a low light intensity and a low mingled color temperature;

wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the light-emitting unit including the first LED load and the second LED load is switched off;

wherein when a motion signal is detected by the motion sensing unit, at least the second LED load is switched on by the loading and power control unit, wherein the controller outputs at least a second control signal to control at least a second conduction rate of the switching circuitry such that a high electric power is delivered to the light-emitting unit to perform a high level illumination mode emitting light with a high light intensity and a high mingled color temperature for a predetermined time duration before switching back to the low level illumination mode;

wherein the at least one external control unit generates at least one external control signal for adjusting or selecting at least one operating parameter including the light intensity of the low level illumination mode and the mingled color temperature of the low level illumination mode, the light intensity of the high level illumination mode, the mingled color temperature of the high level illumination mode and a time length of the predetermined time duration;

wherein the LEDs of the first LED load and the LEDs of the second LED load are respectively designed with a configuration of in series and/or in parallel connections such that when incorporated with an adequate level setting of the power source an electric current passing through each LED of the first LED load and each LED of the second LED load remains at an adequate level such that a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of an LED, where V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across the LED to avoid a thermal damage or burning out of LED construction.

45. The two-level LED security light according to claim **44**, wherein when each of the first LED load and the second LED load is configured with a plurality of LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series, a working voltage across the first LED load or the second LED load is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series and a maximum voltage equal to the sum

of the maximum voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series.

46. The two-level LED security light according to claim **45**, wherein the LED has the voltage V across each LED complying with an operating constraint of 2.5 volts $<V_{th}<V<V_{max}<$3.5 volts and the working voltages imposed on the first LED load and the second LED load respectively represented by V_N and V_M are confined in domains expressed by N×2.5 volts $<V_N<$N×3.5 volts and M×2.5 volts $<V_M<$M×3.5 volts, wherein N and M are positive integrals denoting respective numbers of series connected LEDs in the first LED load and the second LED load.

47. The two-level LED security light according to claim **44**, wherein when the light-emitting unit is operated in the low level illumination mode, the light intensity of the first LED load and the light intensity of the second LED load are respectively adjustable to tune the mingled color temperature of the diffused light created thru the light diffuser; wherein upon receiving the at least one external control signal from the at least one external control unit the controller operates in response to simultaneously but reversely adjust the light intensity of the first LED load and the light intensity of the second LED load with the same pace; wherein for changing to a lower mingled color temperature, the controller upon receiving the at least one external control signal operates to control the switching circuitry to increase a first electric power delivered to the first LED load and at the same time to decrease a second electric power delivered to the second LED lighting load; wherein for changing to a higher mingled color temperature, the controller upon receiving the external control signal operates to control the switching circuitry to decrease the first electric power delivered to the first LED lighting load and at the same time to increase the second electric power delivered to the second LED lighting load such that a sum of the first electric power and the second electric power remains unchanged and is equal to the low electric power in the low level illumination mode.

48. The two-level LED security light according to claim **44**, wherein when the light-emitting unit is operated in the high level illumination mode, the light intensity of the first LED load and the light intensity of the second LED load are respectively adjustable to tune the mingled color temperature of the diffused light created thru the light diffuser; wherein upon receiving the at least one external control signal from the at least one external control unit the controller operates in response to simultaneously but reversely adjust the light intensity of the first LED load and the light intensity of the second LED load with the same pace; wherein for changing to a lower mingled color temperature, the controller upon receiving the at least one external control signal operates to control the switching circuitry to increase a first electric power delivered to the first LED load and at the same time to decrease a second electric power delivered to the second LED load such that a sum of the first electric power and the second electric power remains unchanged; wherein for changing to a higher mingled color temperature, the controller upon receiving the external control signal operates to control the switching circuitry to decrease the first electric power delivered to the first LED load and at the same time to increase the second electric power delivered to the second LED load such that the sum of the first electric power and the second electric power remains unchanged and is equal to the high electric power in the high level illumination mode.

49. The two-level LED security light according to claim **44**, wherein the controller is programmed to operate with at least one color temperature switching scheme for selecting the mingled color temperature of the low level illumination mode or the mingled color temperature of the high level illumination mode, wherein paired combinations of different conduction rates of the switching circuitry for controlling different electric powers to be respectively delivered to the first LED load and the second LED load for creating different mingled color temperatures are preprogrammed and stored in a memory unit addressable by the controller for operating a pick and play process according to the at least one external control signal received and interpreted by the controller for performing a selected mingled color temperature; wherein in programming the paired combinations of different conduction rates of the switching circuitry, a first electric power delivered to the first LED load and a second electric power delivered to the second LED load are complementarily and reversely adjusted such that a total of the first electric power delivered to the first LED load and the second electric power delivered to the second LED load remain essentially unchanged.

50. The two-level LED security light according to claim **49**, wherein the at least one external control unit includes at least one voltage divider and the at least one external control signal is a voltage output of the voltage divider set by a user, for selecting a color temperature performance of the at least one color temperature tuning scheme.

51. The two-level LED security light according to claim **49**, wherein the at least one external control unit includes at least one push button or one touch pad and the at least one external control signal is a short voltage signal with a time length corresponding to a time duration of the push button or the touch pad being operated by a user, wherein upon receiving the short voltage signal the controller operates the pick and play process to alternately perform a selected mingled light color temperatire in the color temperature switching scheme according to a preset sequence.

52. The two-level LED security light according to claim **49**, wherein the at least one external control unit is a wireless remote control receiver and the at least one external control signal is a wireless signal transmitted from a mobile device.

53. The two-level LED security light according to claim **49**, wherein in tuning the mingled color temperature the controller operates to simultaneously but reversely adjust the light intensity of the first LED load and the light intensity of the second LED load with an arrangement that a total electric power of the light-emitting unit is kept essentially unchanged during adjusting process.

54. The two-level LED security light according to claim **49**, wherein the at least one external control unit is a power interruption detection circuitry electrically coupled to the controller for detecting a short power interruption signal; wherein when the short power interruption signal is detected, the controller operates to alternately switch a selection of different mingled color temperatures according to the at least one color temperature tuning scheme preprogrammed.

55. A lifestyle LED security light comprising:

- a light-emitting unit, configured with at least a first LED load for emitting light with a low color temperature and at least a second LED load for emitting light with a high color temperature;
- a diffuser covering the first LED load and the second LED load to create a diffused light with a mingled color temperature;
- a loading and power control unit;

a light sensing control unit;
a motion sensing unit;
a power supply unit; and
at least one external control unit;
wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the controller is electrically and respectively coupled with the light sensing control unit, the motion sensing unit, the switching circuitry and the at least one external control unit;
wherein the switching circuitry is electrically coupled between a power source of the power supply unit and the light-emitting unit, wherein the power source is a DC power source configured in the power supply unit;
wherein the switching circuitry comprises at least a first semiconductor switching device and at least a second semiconductor switching device;
wherein the first LED load and the second LED load are connected in parallel and are further respectively and electrically coupled to the first semiconductor switching device and the second semiconductor switching device;
wherein the controller outputs a first control signal to control a first conduction rate of the first semiconductor switching device for delivering a first electric power to the first LED load and simultaneously a second control signal to control a second conduction rate of the second semiconductor switching device for delivering a second electric power to the second LED load such that the light-emitting unit respectively generates illuminations of different light intensities and different mingled color temperatures for performing different illumination modes according to signals respectively received from the light sensing control unit, the motion sensing unit and the at least one external control unit;
wherein when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the light-emitting unit is switched on to perform a first illumination mode with the motion sensing unit being temporarily deactivated;
wherein the controller outputs at least the first control signal to control at least the first conduction rate of at least the first semiconductor switching device such that a total electric power is delivered to the light-emitting unit to perform the first illumination mode with a first level illumination characterized by a first light intensity and a first mingled color temperature for a first predetermined time duration;
wherein upon a maturity of the first predetermined time duration the loading and power control unit manages to cutoff the total electric power delivered to the light-emitting unit and at the same time the motion sensing unit is activated;
wherein when a motion signal is detected by the motion sensing unit, the controller operates to output at least the second control signal to control at least the second conduction rate of at least the second semiconductor switching device to increase the total electric power delivered to the light-emitting unit to perform a second illumination mode with a second level illumination characterized by a second light intensity and a second mingled color temperature for a second predetermined time duration before being switched back to the turned off state, wherein the second light intensity of the second level illumination is equal to or higher than the first light intensity of the first level illumination;
wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the light-emitting unit including the first LED load and the second LED load is switched off;
wherein the at least one external control unit is a voltage divider, a push button, a touch pad, a wireless signal receiver or a power interruption detection circuitry, generating at least one external control signal to the controller for adjusting or selecting at least one operating parameter of the light-emitting unit including the light intensity, the mingled color temperature, a time length for the first predetermined time duration or a time length for the second predetermined time duration respectively in the first illumination mode or in the second illumination mode;
wherein the LEDs of the first LED load and the LEDs of the second LED load are respectively designed with a configuration of in series and/or in parallel connections such that when incorporated with an adequate level setting of the power source of the power supply unit an electric current passing through each LED of the first LED load and each LED of the second LED load remains at an adequate level such that a voltage V across each LED chip complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED chip, where V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across the LED to avoid a thermal damage or burning out of LED construction.

56. The lifestyle LED security light according to claim **55**, wherein when each of the first LED load and the second LED load is configured with a plurality of LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series, a working voltage across the first LED load or the second LED load is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum voltages of all LEDs electrically connected in sereis or sets of in parallel connected LEDs electrically connected in series.

57. The lifestyle LED security light according to claim **56**, wherein the LED has the voltage V across each LED complying with an operating constraint of 2.5 volts $<V_{th}<V<V_{max}<$3.5 volts and the working voltages imposed on the first LED load and the second LED load respectively represented by V_N and V_M are confined in domains expressed by N×2.5 volts $<V_N<$N×3.5 volts and M×2.5 volts $<V_M<$M×3.5 volts, wherein N and M are positive integrals denoting respective numbers of series connected LEDs in the first LED load and in the second LED load.

58. The lifestyle LED security light according to claim **55**, wherein the first mingled color temperature of the first level illumination in performing the first illumination mode is the low color temperature, wherein the second semiconductor switching device is in a cutoff state and the controller outputs only the first control signal to control the first conduction rate of the first semiconductor switching device to deliver the total electric power to the light-emitting unit to determine the light intensity of the first illumination mode.

59. The lifestyle LED security light according to claim **55**, wherein the second mingled color temperature of the second level illumination in performing the second illumination

mode is the high color temperature, wherein the first semiconductor switching device is in a cutoff state and the controller outputs only the second control signal to control the second conduction rate of the second semiconductor switching device to deliver the total electric power to the light-emitting unit to determine the light intensity of the second illumination mode.

60. The lifestyle LED security light according to claim **55**, wherein when the light-emitting unit is in the first illumination mode, a light intensity of the first LED load and a light intensity of the second LED load are respectively adjustable to tune the mingled color temperature of the diffused light created thru the light diffuser; wherein upon receiving an external control signal from the external control unit the controller operates to simultaneously but reversely adjust the light intensity of the first LED load and the light intensity of the second LED load with the same pace; wherein for changing to a lower mingled color temperature, the controller upon receiving the external control signal operates to control the first semiconductor switching device to increase the first electric power delivered to the first LED load and at the same time operates to control the second semiconductor switching device to proportionally decrease the second electric power delivered to the second LED load; wherein for changing to a higher mingled color temperature, the controller upon receiving the external control signal operates to control the first semiconductor switching device to decrease the first electric power delivered to the first LED load and at the same time operates to control the second semiconductor switching device to proportionally increase the second electric power delivered to the second LED load.

61. The lifestyle LED security light according to claim **60**, wherein when the light-emitting unit is in the first illumination mode, the controller is programmed to operate with a color temperature swicthing scheme, wherein paired combinations of different conduction rates between operating the first semiconductor switching device and the second semiconductor switching device for controlling the first electric power and the second electric power respectively delivered to the first LED load and the second LED load for creating different mingled color temperatures are preprogrammed and stored in a memory unit addressable by the controller for operating a pick and play process according to the at least one external control signal received and interpreted by the controller for performing a selected mingled color temperature.

62. The lifestyle LED security light according to claim **55**, wherein when the light-emitting unit is in the second illumination mode, the light intensity of the first LED load and the light intensity of the second LED load are respectively adjustable to tune the mingled color temperature thru the light diffuser; wherein upon receiving an external control signal from the at least one external control unit the controller operates to simultaneously but reversely adjust the light intensity of the first LED load and the light intensity of the second LED load with the same pace; wherein for changing to a lower mingled color temperature, the controller upon receiving the external control signal operates to control the first semiconductor switching device to increase the first electric power delivered to the first LED load and at the same time operates to control the second semiconductor switching device to proportionally decrease the second electric power delivered to the second LED load; wherein for changing to a higher mingled color temperature, the controller upon receiving the external control signal operates to control the first semiconductor switching device to decrease the first electric power delivered to the first LED load and at the same time operates to control the second semiconductor switching device to proportionally increase the second electric power delivered to the second LED load.

63. The lifestyle LED security light according to claim **62**, wherein when the light-emitting unit is in the second illumination mode, the controller is programmed to operate with a color temperature switching scheme, wherein paired combinations of different condcution rates between operating the first semiconductor switching device and the second semiconductor switching device for controlling the first electric power and the second electric to be respectively delivered to the first LED load and the second LED load for creating different mingled color temperatures are preprogrammed and stored in a memory unit addressable by the controller for operating a pick and play process according to the external control signal received and interpreted by the controller for performing a selected mingled color temperature.

64. The lifestyle LED security light according to claim **62**, wherein the at least one external control unit includes at least one voltage divider and the at least one external control signal is a voltage output of the voltage divider set by a user, for activating the pick and play process for selecting a corresponding mingled color temperature performance in the at least one color temperature tuning scheme.

65. The lifestyle LED security light according to claim **63**, wherein the at least one external control unit includes at least one voltage divider and the at least one external control signal is a voltage output of the voltage divider set by a user, for activating the pick and play process for selecting a corresponding mingled color temperature performance in the at least one color temperature tuning scheme.

66. The lifestyle LED security light according to claim **61**, wherein the at least one external control unit includes at least one wireless signal receiver to receive a wireless external control signal from a mobile device, a smart phone or a smart speaker for activating the pick and play process for selecting a corresponding mingled color temperature performance in the at least one color temperature switching scheme.

67. A lifestyle LED security light comprising:

- a light-emitting unit, configured with at least a first LED load for emitting light with a low color temperature and at least a second LED load for emitting light with a high color temperature;
- a diffuser covering the first LED load and the second LED load to create a diffused light with a mingled color temperature;
- a loading and power control unit;
- a light sensing control unit;
- a motion sensing unit;
- a power supply unit; and
- at least one external control unit; and
- wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the controller is electrically and respectively coupled with the light sensing control unit, the motion sensing unit, the switching circuitry and the at least one external control unit;
- wherein the switching circuitry is electrically coupled between at least one power source of the power supply unit and the light-emitting unit, wherein the power source is a DC power source configured in the power supply unit;
- wherein the switching circuitry comprises at least a first semiconductor switching device and a second semiconductor switching device;

wherein the first LED load and the second LED load are connected in parallel and are further respectively and electrically coupled to the first semiconductor switching device and the second semiconductor switching device;

wherein the controller outputs a first control signal to control a first conduction rate of the first semiconductor switching device for delivering a first electric power to the first LED load and simultaneously a second control signal to control a second conduction rate of the second semiconductor switching device for delivering a second electric power to the second LED load such that the light-emitting unit respectively generates illuminations of different light intensities and different mingled color temperatures for performing different illumination modes according to signals respectively received from the light sensing control unit, the motion sensing unit and the at least one external control unit;

wherein when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the light-emitting unit is switched on to perform a first illumination mode with the motion sensing unit being temporarily deactivated; wherein the controller outputs at least the first control signal to control at least the first conduction rate of at least the first semiconductor switching device such that a total electric power is delivered to the light-emitting unit to perform the first illumination mode with a first level illumination characterized by a first light intensity and a first mingled color temperature for a first predetermined time duration;

wherein upon a maturity of the first predetermined time duration the loading and power control unit manages to reduce the total electric power delivered to the light-emitting unit to generate a low level illumination characterized by a low light intensity and at the same time the motion sensing unit is activated;

wherein when a motion signal is detected by the motion sensing unit, the controller operates to output at least the second control signal to control at least the second conduction rate of at least the second semiconductor switching device to increase the total electric power delivered to the light-emitting unit to perform a second illumination mode with a second level illumination characterized by a second light intensity and a second mingled color temperature for a second predetermined time duration before being switched back to the low level illumination, wherein the second light intensity of the second level illumination is equal to or higher than the first light intensity of the first level illumination, wherein the first light intensity is equal to or higher than the low light intensity of the low level illumination;

wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the light-emitting unit including the first LED load and the second LED load is switched off;

wherein the at least one external control unit is a voltage divider, a push button, a touch pad, a wireless signal receiver or a power interruption detection circuitry, generating at least one external control signal for adjusting or selecting at least one operating parameter of the light-emitting unit including the light intensity, the mingled color temperature, a time length for the first predetermined time duration or a time length for the second predetermined time duration respectively in the first illumination mode or in the second illumination mode;

wherein the LEDs of the first LED load and the LEDs of the second LED load are respectively designed with a configuration of in series and/or in parallel connections such that when incorporated with an adequate level setting of the power source of the power supply unit an electric current passing through each LED of the first LED load and each LED of the second LED load remains at an adequate level such that a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of a LED, where V_{th} is a threshold voltage required to trigger the LED to start emitting light and V_{max} is a maximum operating voltage across the LED to avoid a thermal damage or burning out of LED construction.

68. The lifestyle LED security light according to claim **67**, wherein when each of the first LED load and the second LED load is configured with a plurality of LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series, a working voltage across the first LED load or the second LED load is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series.

69. The lifestyle LED security light according to claim **68**, wherein the LED has the voltage V across each LED complying with an operating constraint of 2.5 volts $<V_{th}<V<V_{max}<$3.5 volts and the working voltages imposed on the first LED load and the second LED load respectively represented by V_N and V_M are confined in domains expressed by N×2.5 volts $<V_N<$N×3.5 volts and M×2.5 volts $<V_M<$M×3.5 volts, wherein N and M are positive integrals denoting respective numbers of series connected LEDs in the first LED load and the second LED load.

70. The lifestyle LED security light according to claim **67**, wherein the first mingled color temperature in performing the first illumination mode is the low color temperature, wherein the second semiconductor switching device is in a cutoff state and the controller outputs only the first control signal to control the first conduction rate of the first semiconductor switching device to deliver the total electric power to the light-emitting unit to determine the light intensity and the mingled color temperature of the first illumination mode.

71. The lifestyle LED security light according to claim **67**, wherein the second mingled color temperature in performing the second illumination mode is the high color temperature, wherein the first semiconductor switching device is in a cutoff state and the controller outputs only the second control signal to control the second conduction rate of the second semiconductor switching device to deliver the total electric power to the light-emitting unit to determine the light intensity of the second illumination mode.

72. The lifestyle LED security light according to claim **67**, wherein when the light-emitting unit is in the first illumination mode, a light intensity of the first LED lighting load and a light intensity of the second LED lighting load are respectively adjustable to tune the mingled color temperature of the diffused light thru the light diffuser; wherein upon receiving an external control signal from the at least one external control unit the controller operates to simultaneously but reversely adjust the light intensity of the first LED lighting load and the light intensity of the second LED

lighting load with the same pace; wherein for changing to a lower mingled color temperature, the controller upon receiving the external control signal operates to control the first semiconductor switching device to increase the first electric power delivered to the first LED load and at the same time proportionally decrease the second electric power delivered to the second LED load; wherein for changing to a higher mingled color temperature, the controller upon receiving the external control signal operates to control the first semiconductor switching device to decrease the first electric power delivered to the first LED load and at the same time proportionally increase the second electric power delivered to the second LED load.

73. The lifestyle LED security light according to claim **72**, wherein when the light-emitting unit is in the first illumination mode, the controller is programmed to operate with a color temperature tuning scheme, wherein paired combinations of different conduction rates between operating the first semiconductor switching device and the second semiconductor switching device for controlling the first electric power and the second electric power respectively delivered to the first LED load and the second LED load for creating different mingled color temperatures are preprogrammed and stored in a memory unit addressable by the controller for operating a pick and play process according to the external control signal received and interpreted by the controller for performing a selected mingled color temperature.

74. The lifestyle LED security light according to claim **67**, wherein when the light-emitting unit is in the second illumination mode, a light intensity of the first LED lighting load and a light intensity of the second LED lighting load are respectively adjustable to tune the mingled color temperature thru the light diffuser; wherein upon receiving an external control signal from the at least one external control unit the controller operates to simultaneously but reversely adjust the light intensity of the first LED lighting load and the light intensity of the second LED lighting load with the same pace; wherein for changing to a lower mingled color temperature, the controller upon receiving the external control signal operates to control the first semiconductor switching device to increase the first electric power delivered to the first LED load and at the same time operates to control the second semiconductor switching device to proportionally decrease the second electric power delivered to the second LED load; wherein for changing to a higher mingled color temperature, the controller upon receiving the external control signal operates to control the first semiconductor switching device to decrease the first electric power delivered to the first LED load and at the same time operates to control the second semiconductor switching device to proportionally increase the second electric power delivered to the second LED load.

75. The lifestyle LED security light according to claim **74**, wherein when the light-emitting unit is in the second illumination mode, the controller is programmed to operate with a color temperature tuning scheme, wherein paired combinations of different conduction rates between operating the first semiconductor switching device and the second semiconductor switching device for controlling the first electric power and the second electric power respectively delivered to the first LED load and the second LED load for creating different mingled color temperatures are preprogrammed and stored in a memory unit addressable by the controller for operating a pick and play process according to the external control signal received and interpreted by the controller for performing a selected mingled color temperature.

76. The lifestyle LED security light according to claim **73**, wherein the at least one external control unit includes at least one voltage divider and the at least one external control signal is a voltage output of the voltage divider set by a user, for activating the pick and play process for selecting a corresponding mingled color temperature performance in the at least one color temperature tuning scheme.

77. The lifestyle LED security light according to claim **75**, wherein the at least one external control unit includes at least one voltage divider and the at least one external control signal is a voltage output of the voltage divider set by a user, for activating the pick and play process for selecting a corresponding mingled color temperature performance in the at least one color temperature tuning scheme.

78. The lifestyle LED security light according to claim **73**, wherein the at least one external control unit include at least one wireless signal receiver to receive a wireless external control signal from a mobile device, a smart phone or a smart speaker for activating the pick and play process for selecting a corresponding mingled color temperature performance in the at least one color temperature switching scheme.

79. A lifestyle LED security light, comprising:

a light-emitting unit, including at least a first LED load configured with a plurality of LEDs emitting light with a first color temperature;

a loading and power control unit;

a light sensing control unit;

a motion sensing unit;

a time setting unit; and

a power supply unit;

wherein the loading and power control unit comprises a controller and a switching circuitry, wherein the controller is electrically coupled with the light sensing control unit, the motion sensing unit, the switching circuitry and the time setting unit, wherein the switching circuitry is electrically connected between a power source and the light-emitting unit to control and output an electric power to the light-emitting unit, wherein the switching circuitry comprises at least a first semiconductor switching device, wherein the controller outputs a control signal to control a conduction rate of the switching circuitry for delivering different electric powers from the power source to drive the light-emitting unit for generating different illuminations characterized by different light intensities according to signals respectively received from the light sensing control unit and the motion sensing unit;

wherein the power source configured in the power supply unit outputs at least a DC power for operating the LED lighting device;

wherein the control signals are pulse width modulation signals;

wherein when an ambient light detected by the light sensing control unit is lower than a first predetermined value, the loading and power control unit is activated to switch on the light-emitting unit to perform a first illumination mode to generate a first level illumination for a first predetermined time duration preset by the time setting unit, wherein when a motion intrusion signal is detected by the motion sensing unit, the loading and power control unit in response manages to increase the electric power delivered to the light-emitting unit to perform a second illumination mode to generate a second level illumination for a second predetermined time duration preset by the time setting unit, wherein the light intensity of the second level

illumination is higher than the light intensity of the first level illumination, wherein when the ambient light detected by the light sensing control unit is higher than a second predetermined value, the loading and power control unit is activated to switch off the light-emitting unit;

wherein the first level illumination is a low level illumination and the second level illumination is a high level illumination, wherein during a performance of the first illumination mode, the low level illumination creates three advantages for performing a lifestyle lighting solution, wherein a first advantage is a creation of an aesthetic night scene when people are outside of a detection area of the motion sensor, wherein a second advantage is the creation of a navigation capacity similar to a light house for guiding people to safely walk to a destination in an outdoor living area, wherein a third advantage is a prevention of a hardship of light being unexpectedly and completely shutoff while a person is still in the detection space due to expiration of a timer and a simple motion by the person can immediately bring the LED security light back to the high level illumination;

wherein a configuration of the plurality of LEDs of the light-emitting unit is designed with a combination of in series and/or in parallel connections such that when incorporated with a level setting of the DC power, an electric current passing through each LED of the light-emitting unit remains at a level such that a voltage V across each LED complies with an operating constraint of $V_{th}<V<V_{max}$ featuring electrical characteristics of the LED, wherein V_{th} is a threshold voltage required to trigger each LED to start emitting light and V_{max} is a maximum operating voltage across each LED to avoid a thermal damage or burning out of LED construction.

80. The lifestyle LED security light according to claim **79**, wherein the first LED load of the light-emitting unit is configured with a plurality of LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series, a working voltage across the light-emitting unit is confined in a domain between a minimum voltage equal to the sum of the threshold voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series and a maximum voltage equal to the sum of the maximum operating voltages of all LEDs electrically connected in series or sets of in parallel connected LEDs electrically connected in series.

81. The lifestyle LED security light according to claim **80**, wherein the LED has the voltage V across each LED complying with an operating constraint of 2.5 volts $<V_{th}<V<V_{max}<$3.5 volts and the working voltage imposed on the light-emitting unit represented by V_N is confined in domains expressed by N×2.5 volts $<V_N<$N×3.5 volts, wherein N is the number of LEDs electrically connected in series in the first LED load of the light emitting unit.

82. The lifestyle LED security according to claim **79**, wherein the power supply unit is configured with an AC/DC power converter to convert an AC power into a least one DC power required for operating the LED security light.

83. The lifestyle LED security light according to claim **79**, wherein the power supply unit comprises a battery module to output at least one DC power for operating the lifestyle LED security light.

84. The lifestyle LED security light according to claim **83**, wherein the battery module is a rechargeable battery module.

85. The lifestyle LED security light according to claim **84**, wherein the rechargeable battery module is a solar battery module including a solar panel, a charging circuitry and a rechargeable battery.

86. The lifestyle LED security light according to claim **79**, wherein a wireless remote control device is further installed and is electrically coupled with the controller, wherein the remote control device is configured with a wireless receiver and a wireless transmitter to receive a motion intrusion signal detected from a neighboring LED security light and/or to transmit the motion intrusion signal to at least one neighboring LED security light;

wherein when the motion intrusion signal is detected by the motion sensing unit, the controller synchronously operates to transmit the motion intrusion signal thru the wireless transmitter to control a lighting performance of at least one neighboring LED security light;

wherein when the motion intrusion signal detected from a neighboring LED security light is received by the wireless receiver, the controller operates to synchronously increase the conduction rate of the switching device to increase the electric power delivered to the light-emitting unit to perform the high level illumination for the second predetermined time duration.

87. The lifestyle LED security light according to claim **86**, wherein the wireless signal for operating the wireless remote control device is a Wi-Fi wireless signal, a Blue Tooth wireless signal, a Zig Bee wireless signal, or a radio frequency wireless signal.

88. The lifestyle LED security light according to claim **79**, wherein a second LED load to emit light with a second color temperature is further installed in the light emitting unit to be in parallel with the first LED load; wherein a light diffuser is further installed to cover the first LED load and the second LED load, wherein the first color temperature is a low color temperature and the second color temperature is a high color temperature; wherein a second semiconductor switching device and a third semiconductor switching device are further installed between the switching circuitry and the light emitting unit; wherein the second semiconductor switching device is electrically coupled between the switching circuitry and the first LED load, wherein the third semiconductor switching device is electrically coupled between the switching circuitry and the second LED load, wherein the second semiconductor switching device and the third semiconductor switching device are electrically coupled with the controller to form a power allocation circuitry for dividing the electric power from the switching circuitry into a first electric power delivered to the first LED load and a second electric power delivered to the second LED load; wherein at least one external control device operable by a user is further installed to be electrically coupled with the controller generating at least one external control signal to the controller, wherein upon receiving the at least one external control signal the controller responsively outputs at least a first control signal to control a conduction rate of the second semiconductor switching device and at least a second control signal to control the conduction rate of the third semiconductor switching device to respectively deliver the first electric power to the first LED load and the second electric power to the second LED load to generate the illumination with a mingled color temperature thru the light diffuser;

wherein for changing to a lower mingled color temperature, the controller upon receiving the at least one external control signal operates to control the second semiconductor switching device to increase the first electric power delivered to the first LED load and at the same time operates to control the third semiconductor switching device to decrease the second electric power delivered to the second LED load such that a total of the first electric power and the second electric power remains unchanged;

wherein for changing to a higher mingled color temperature, the controller upon receiving the at least one external control signal operates to control the second semiconductor switching device to decrease the first electric power delivered to the first LED load and at the same time operates to control the third semiconductor switching device to increase the second electric power delivered to the second LED load such that the total of the first electric power and the second electric power remains unchanged.

89. The lifestyle LED security light according to claim **88**, wherein the controller is programmed to operate with at least one color temperature switching scheme for selecting the mingled color temperature of the first level illumination mode or the mingled color temperature of the second level illumination mode, wherein paired combinations of the first electric power delivered to the first LED load and the second electric power delivered to the second LED load for creating different mingled color temperatures are preprogrammed and stored in a memory unit addressable by the controller for operating a pick and play process according to the at least one external control signal received and interpreted by the controller for performing a selected mingled color temperature.

* * * * *

EXHIBIT F

Home / Lighting / Outdoor Lighting / Outdoor Security Lighting / Flood Lights

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Exclusive

Defiant

180° White Motion Activated Outdoor Integrated LED Twin Head Flood Light with Adjustable Color Temperature

★★★★½ (340)   Write a Review   Questions & Answers (43)

- Hardwired Floodlight featuring wall or eave-mount installation
- 180-degree motion detection with up to 70 ft. range
- Integrated LED with 2350 lumen output and 31.64 watt equivalence

$89.97

Fixture Color/Finish: **White**

IMAGE UNAVAILABLE

Light Beam Angle: **180**

180 | 270

Quantity - 1 +

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Product Overview

Make your home more secure and stylish with this motion activated outdoor flood light. The Adjustable Color Temperature feature lets you adjust the light from Warm White (3,000k) to Day Light (5,000k) to coordinate with your outdoor decorative lighting. The DualBrite feature warns would-be intruders away with its 2350 lumen light output, so you enjoy a safer, more beautiful home.

- Adjustable color temperature feature allows you to adjust the color temperature from warm white (3,000k) to day light (5,000k) with a simple dial control located on the bottom of the motion sensor
- DualBrite 2-level lighting comes pre-set at a warm white (3,000k) temperature, this feature beautifies, protects and saves energy by utilizing accent light from dusk-to-dawn and full light when motion is detected
- Bright LED at 2350 Lumen output
- 180° motion detection with up to 70 ft. range
- Tool-free lamp head and sensor adjustment
- DIY friendly with 3 easy steps to installation
- Eave or wall mount
- Operating temperature range: -25°C (-13°F) to +50°C (+120°F)
- Click here for more information on Electronic Recycling Programs

Info & Guides

- Instructions / Assembly
- Troubleshooting Guide
- Warranty

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Specifications

Dimensions

Product Depth (in.)	
9.54	

Product Height (in.)	6.36
Product Length (in.)	9.54
Product Width (in.)	7.13

Details

Actual Color Temperature (K)	5000
Adjustable Detection Sensitivity	Yes
Adjustable Lamp Head	Yes
Color Rendering Index (CRI)	82
Color Temperature	Daylight
Detection Range (ft.)	70
Dusk to Dawn	Yes
Exterior Lighting Product Type	Floodlights

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Fixture Color/Finish
White
Fixture Material
Plastic
Glass/Lens Type
Frosted
Included
Hardware Included,Motion Sensor
Light Beam Angle
180
Lumens
2350
Motion Sensing
Yes
Number of Lights
2 Lights
Outdoor Lighting Features
Adjustable Detection Sensitivity,Adjustable Lamp Head,Dusk to Dawn,Motion Sensing,Weather Resistant
Power Options
Hardwired
Power Type
Hardwired
Product Weight (lb.)

1.97lb
Returnable
90-Day
Timer Included
Yes
Voltage
Line Voltage
Watt Equivalence
31.64

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Warranty / Certifications

Certifications and Listings
1-UL Listed,ETL Listed,FCC Listed
Manufacturer Warranty
5 Years

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Exclusive

Defiant

180° Bronze Motion Activated Outdoor Integrated LED Twin Head Flood Light with Adjustable Color Temperature

★★★★½ (340) Write a Review Questions & Answers (43)

- Hardwired Floodlight featuring Wall or Eave-mount Installation
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- Integrated LED with 2350 lumen output and 31.64 watt equivalence

$89.97

Fixture Color/Finish: **Bronze**

Light Beam Angle: **180**

180 | 270

Quantity - 1 +

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Product Overview

The New Defiant Twin Head Adjustable Color Temperature LED motion security light with DualBrite chases away night time darkness with a bright 2350 lumen light output. The Adjustable Color Temperature Feature allows you to adjust the color temperature from Warm White (3,000k) to Day Light (5,000k). This feature allows you to coordinate outdoor Decorative Lighting and Landscape lighting with your new Security Light for a Safe and Beautiful home.

- Adjustable color temperature feature allows you to adjust the color temperature from warm white (3,000k) to day light (5,000k) with a simple dial control located on the bottom of the motion sensor
- DualBrite 2-level light comes pre-set at a warm white (3,000k) temperature and this feature beautifies, protects and saves energy by utilizing accent light from dusk-to-dawn and full light when motion is detected
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Exterior Lighting Product Type	Floodlights

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Glass/Lens Type
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Hardware Included,Motion Sensor
Light Beam Angle
180
Lumens
2350
Motion Sensing
Yes
Number of Lights
2 Lights
Outdoor Lighting Features
Adjustable Detection Sensitivity,Adjustable Lamp Head,Dusk to Dawn,Motion Sensing,Weather Resistant
Power Options
Hardwired
Power Type
Hardwired
Product Weight (lb.)

1.97lb
Returnable
90-Day
Timer Included
Yes
Voltage
Line Voltage
Watt Equivalence
31.64

Warranty / Certifications

Certifications and Listings
1-UL Listed,ETL Listed,FCC Listed
Manufacturer Warranty
5 Year

Recently Viewed Items

Defiant 180° White
Motion Activated
Outdoor Integrated

Home / Lighting / Outdoor Lighting / Outdoor Security Lighting / Flood Lights

Model # DFI-5886-WH Internet #301886028 Store SKU #1002578077

Share Save to Favorites Print

Exclusive

Defiant

270-degree White Motion Activated Outdoor Integrated LED Triple Head Flood Light with Adjustable Color Temperature

(340) Write a Review Questions & Answers (43)

- Adjustable color temperature from warm white to daylight settings
- 3 lamp heads for maximum light coverage
- Easy to install with three easy steps

$109.00

Fixture Color/Finish: **White**

Light Beam Angle: **270**

180 | 270

Quantity - 1 +

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4 **in stock** at Sixes Road

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Delivery Options

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Product Overview

The New Defiant Triple Head Adjustable Color Temperature LED motion security light with DualBrite chases away night time darkness with a bright 2350 lumen light output. The Adjustable Color Temperature Feature allows you to adjust the color temperature from Warm White (3,000k) to Day Light (5,000k). This feature allows you to coordinate outdoor Decorative Lighting and Landscape lighting with your new Security Light for a Safe and Beautiful home.

- Adjustable color temperature feature allows you to adjust the color temperature from warm white (3,000k) to day light (5,000k) with a simple dial control located on the bottom of the motion sensor
- DualBrite 2-level light comes pre-set at a warm white (3,000k) temperature, feature beautifies, protects and saves energy by utilizing accent light from dusk-to-dawn and full light when motion is detected
- Bright LED at 3000 Lumen output
- 3 individual lamp heads allow light placement on the ground where you need it
- 270-degree motion detection with up to 70 ft. range: wall or eave mount
- Tool-free lamp head and sensor adjustment
- DIY friendly with 3 easy steps to installation
- Operating temperature range: -25-degreeC (-13-degreeF) to +50-degreeC (+120-degreeF)
- Click here for more information on Electronic Recycling Programs

Info & Guides

- Instructions / Assembly
- Troubleshooting Guide
- Warranty

You will need Adobe® Acrobat® Reader to view PDF documents. Download a free copy from the Adobe Web site.

Specifications

Dimensions

Product Depth (in.)
11.54

Product Height (in.)
6.42
Product Length (in.)
11.54
Product Width (in.)
7.08

Details

Actual Color Temperature (K)
5000
Adjustable Detection Sensitivity
Yes
Adjustable Lamp Head
Yes
Color Rendering Index (CRI)
82
Color Temperature
Daylight
Detection Range (ft.)
70
Dusk to Dawn
Yes
Exterior Lighting Product Type
Floodlights

Fixture Color/Finish
White
Fixture Material
Plastic
Glass/Lens Type
Frosted
Included
Hardware Included,Motion Sensor
Light Beam Angle
270
Lumens
3000
Motion Sensing
Yes
Number of Lights
3 Lights
Outdoor Lighting Features
Adjustable Detection Sensitivity,Adjustable Lamp Head,Dusk to Dawn,Motion Sensing,Weather Resistant
Power Options
Hardwired
Power Type
Hardwired
Product Weight (lb.)

2.61lb
Returnable
90-Day
Timer Included
Yes
Voltage
Line Voltage
Watt Equivalence
44.06

Warranty / Certifications

Certifications and Listings
1-UL Listed,ETL Listed,FCC Listed
Manufacturer Warranty
5 Year

Recently Viewed Items

Defiant 180° Bronze Motion Activated Outdoor

Defiant 180° White Motion Activated Outdoor Integrated

Heath Zenith® ColorTune White Integrated LED Tri Head Motion Sensor Outdoor Security Flood Light

Adjustable Color Temperature

Model Number: HZV-5051-WH | Menards® SKU: 3569247

Online Price

$99.97 each

Color: White

FREE Ship To Store
Enter Your ZIP Code for store information

Shipping
Available

Description & Documents

This motion-activated LED security flood light will help bring more security exactly where you need it. With a detection range of 70 feet and a motion detection range of 240 degrees, no space will be left in the dark. The bright, energy saving LED light will automatically turn on when motion is detected and includes the DualBrite® feature. DualBrite® allows the light to provide low-level lighting and illuminates to full brightness when motion is detected for optimal energy savings. The security light also gives you the option to change the color temperature to daylight or to warm white.

Shipping Dimensions: 15.16 H x 9.76 W x 5.91 D
Shipping Weight: 3.75 lbs

Brand Name: **Heath Zenith**

Features

- ColorTune technology allows for change in color temperature
- Mounting hardware included
- DualBrite® technology
- Easy installation mounting plate
- Tool-free sensor and lamp head adjustment
- Dimmable for adjustable light brightness (manual dial on sensor head)
- This LED light has a CRI of 90, an adjustable color temperature of 2700K (Warm light) to 5000K (Daylight), and is 3000 Lumens
- Life expectancy of 30,000 hours

Specifications

Overall Height	7.2 inch	Overall Width	15.5 inch
Overall Depth	6.2 inch	Weight	2.75 pound
Backplate Dimensions	4.38 inch	Lighting Feature	Motion
Product Type	Security Flood Light	Power Source	Direct Wire
Voltage	120V	Degree of Motion Detection	240
Detection Range	70 foot	Number of Bulbs Required	None (uses Integrated LED)
Maximum Wattage per Socket	45	Total Light Wattage	45
Bulb Type	LED	Bulbs Included	No (Integrated LED)
Light Color Temperature	2700-5000 kelvin	Light Output	3000 lumen
Material	Polycarbonate	Fixture Color Family	White
Fixture Color/Finish	White	Shade/Diffuser Material	Plastic
Shade/Diffuser Color/Finish	Frosted	Recommended Environment	Outdoor
Listing Agency Standards	ETL Listed	Manufacturer Warranty	5 year
View Return Policy			

Heath Zenith® ColorTune Bronze Integrated LED Tri Head Motion Sensor Outdoor Security Flood Light

Adjustable Color Temperature

Model Number: HZV-5051-BZ | Menards® SKU: 3569248

Online Price

$99.97 each

Color: Bronze

FREE Ship To Store
Enter Your ZIP Code for store information

Shipping
Available

Description & Documents

This motion-activated LED security flood light will help bring more security exactly where you need it. With a detection range of 70 feet and a motion detection range of 240 degrees, no space will be left in the dark. The bright, energy saving LED light will automatically turn on when motion is detected and includes the DualBrite® feature. DualBrite® allows the light to provide low-level lighting and illuminates to full brightness when motion is detected for optimal energy savings. The security light also gives you the option to change the color temperature to daylight or to warm white.

Shipping Dimensions: 15.16 H x 9.76 W x 5.91 D
Shipping Weight: 3.75 lbs

Brand Name: **Heath Zenith**

Features

- ColorTune technology allows for change in color temperature
- Mounting hardware included
- DualBrite® technology
- Easy installation mounting plate
- Tool-free sensor and lamp head adjustment
- Dimmable for adjustable light brightness (manual dial on sensor head)
- This LED light has a CRI of 90, an adjustable color temperature of 2700K (Warm light) to 5000K (Daylight), and is 3000 Lumens
- Life expectancy of 30,000 hours

Specifications

Overall Height	7.2 inch	Overall Width	15.5 inch
Overall Depth	6.2 inch	Weight	2.75 pound
Backplate Dimensions	4.38 inch	Lighting Feature	Motion
Product Type	Security Flood Light	Power Source	Direct Wire
Voltage	120V	Degree of Motion Detection	240
Detection Range	70 foot	Number of Bulbs Required	None (uses Integrated LED)
Maximum Wattage per Socket	45	Total Light Wattage	45
Bulb Type	LED	Bulbs Included	No (Integrated LED)
Light Color Temperature	2700-5000 kelvin	Light Output	3000 lumen
Material	Polycarbonate	Fixture Color Family	Bronze
Fixture Color/Finish	Bronze	Shade/Diffuser Material	Plastic
Shade/Diffuser Color/Finish	Frosted	Recommended Environment	Outdoor
Listing Agency Standards	ETL Listed	Manufacturer Warranty	5 year
View Return Policy			

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EXHIBIT G

Home / Lighting / Outdoor Lighting / Outdoor Security Lighting / Flood Lights

Internet #308772843 Model # HZ-8813-BZ

Live Chat

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Heath Zenith

Twin Head Bronze Outdoor Integrated LED Dusk to Dawn Activated Flood Light with Adjustable Color Temperature

★★★★★ Write the first Review Ask the first question

$72.58

Save up to $100 on your qualifying purchase.
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Fixture Color/Finish: **Bronze**

Bronze White

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Quantity - 1 +

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Delivery Options

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Live Chat

Product Overview

Introducing Color Tune technology that allows exterior home lighting to be customized from a warm white to daylight color temperature using a simple adjustable dial located on the light. Photocell technology allows the light to operate from dusk to dawn at night time only. LED technology provides long lasting bright energy efficient lighting from safety and security around the perimeter of the home.

- Adjustable color temperature from warm white to daylight by simple dial control
- Operates from dusk-to-dawn
- 1850 Lumens output
- Twin lamp head design with tool-free adjustment
- Energy efficient LED technology
- White finish
- 5 year warranty
- Click here for more information on Electronic Recycling Programs

Info & Guides

- Warranty

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View All (2)


Outdoor Security Li... (1)


Outdoor Wall Lighting (1)

Current Product

Heath Zenith Twin Head Bronze Outdoor Integrated LED Dusk to Dawn Activated Flood Light with Adjustable…

(0)

$72.58 each

Item Selected

Heath Zenith Triple Head Outdoor Integrated LED Dusk to Dawn Activated …

(0)

$96.99

Select This Item

Heath Zenith 1-Light Oil Rubbed Bronze Motion Activated Outdoor Wall Lanter…

(4)

$51.06

Select This Item

Live Chat

1 Item Selected

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PROBRITE High-Output 40-Watt Integrated LED

(126)

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PROBRITE Architectural Round 50 Watt,

(12)

$222.40/package

Was ~~$278~~

Add To Cart

PROBRITE 14-Watt Integrated LED Area and

(3)

$111.96/package

Was ~~$139.96~~

Add To Cart

PROBRITE Bright Bronze 20-Watt Integrated LED

(5)

$95.96/package

Was ~~$119.96~~

Add To Cart

PROBI
Watt Ir
LED W

$103

Was ~~$12~~

Add

Live Chat

Specifications

Dimensions

Product Depth (in.)	
6	
Product Height (in.)	
4.50	
Product Length (in.)	
6	
Product Width (in.)	

8.75 in

Details

Actual Color Temperature (K)	5000
Adjustable Detection Sensitivity	No
Adjustable Lamp Head	Yes
Color Rendering Index (CRI)	84
Color Temperature	White Adjustable Light
Detection Range (ft.)	0
Dusk to Dawn	Yes
Exterior Lighting Product Type	Floodlights
Fixture Color/Finish	Bronze
Fixture Material	Plastic
Glass/Lens Type	Frosted

Included
Mounting Hardware Included
Lumens
1850
Motion Sensing
No
Number of Lights
2 Lights
Outdoor Lighting Features
Adjustable Lamp Head,Dusk to Dawn,Weather Resistant
Pack Size
1 Pack
Power Options
Hardwired
Power Type
Line voltage
Product Weight (lb.)
1.39lb
Returnable
90-Day
Timer Included
No
Voltage

Live Chat

Line Voltage	
Voltage Type	
Line Voltage	

Warranty / Certifications

Certifications and Listings	
ETL Listed	
Manufacturer Warranty	
5 Year	

Live Chat

How can we improve our product information? Provide feedback.

Home / Lighting / Outdoor Lighting / Outdoor Security Lighting / Flood Lights

Internet #308772819 Model # HZ-8813-WH

Live Chat

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Heath Zenith

Twin Head White Outdoor Integrated LED Dusk to Dawn Activated Flood Light with Adjustable Color Temperature

★★★★★ (1) Write a Review Ask the first question

$77.59

Save up to $100 on your qualifying purchase.
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Fixture Color/Finish: **White**

Bronze | **White**

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Quantity - 1 +

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Delivery Options

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Live Chat

Product Overview

Introducing Color Tune technology that allows the exterior home lighting to be customized from a warm white to daylight color temperature using a simple adjustable dial located on the light. Photocell technology allows that light to operate from dusk to dawn at night time only. LED technology provides long lasting bright energy efficient lighting for safety and security around the perimeter of the home.

- Adjustable color temperature from warm white to daylight by a simple dial control
- Operates from dusk to dawn only
- 1850 Lumens output
- Twin lamp head design with toll-free adjustment
- Energy efficient LED technology
- White finish
- 5 year warranty
- Click here for more information on Electronic Recycling Programs

Info & Guides

- Warranty

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Current Product

Heath Zenith Twin Head White Outdoor Integrated LED Dusk to Dawn Activated Flood Light with Adjustable…

(1)

$77.59 each

☐ Item Selected

Heath Zenith Triple Head Outdoor Integrated LED Dusk to Dawn Activated …

(1)

$103.78

☐ Select This Item

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1 Item Selected 

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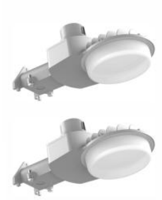
Current Product

Heath Zenith Twin Head White Outdoor Integrated LED Dusk to Dawn Activated

Sponsored Products



PROBRITE High-Output 40-Watt Integrated LED

(126)

127^{96}/package
Was ~~$159.96~~

Add To Cart

PROBRITE Architectural Round 50 Watt,

(12)

222^{40}/package
Was ~~$278~~

Add To Cart

PROBRITE 14-Watt Integrated LED Area and

(3)

111^{96}/package
Was ~~$139.96~~

Add To Cart

PROBRITE Bright Bronze 20-Watt Integrated LED

(5)

95^{96}/package
Was ~~$119.96~~

Add To Cart

PROBI Watt Ir LED W

$103
Was ~~$12~~

Add

Live Chat

Specifications

Dimensions

Product Depth (in.)	
6	
Product Height (in.)	
4.5	
Product Length (in.)	
6	
Product Width (in.)	

8.75 in

Details

Actual Color Temperature (K)	5000
Adjustable Detection Sensitivity	No
Adjustable Lamp Head	Yes
Color Rendering Index (CRI)	84
Color Temperature	White Adjustable Light
Detection Range (ft.)	0
Dusk to Dawn	Yes
Exterior Lighting Product Type	Floodlights
Fixture Color/Finish	White
Fixture Material	Plastic
Glass/Lens Type	Frosted

Included

Mounting Hardware Included

Lumens

1850

Motion Sensing

No

Number of Lights

2 Lights

Outdoor Lighting Features

Adjustable Lamp Head,Dusk to Dawn,Weather Resistant

Pack Size

1 Pack

Power Options

Hardwired

Power Type

Line voltage

Product Weight (lb.)

1.39lb

Returnable

90-Day

Timer Included

No

Voltage

Line Voltage	
Voltage Type	
Line Voltage	

Warranty / Certifications

Certifications and Listings	
ETL Listed	
Manufacturer Warranty	
5 Year	

Live Chat

Recently Viewed Items

Heath Zenith Twin Head Bronze Outdoor Integrated

NOT YET RATED

/**/

Home / Lighting / Outdoor Lighting / Outdoor Security Lighting / Flood Lights

Internet #309814994 Model # HZ-8814-BZ

Live Chat

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Heath Zenith

Triple Head Outdoor Integrated LED Dusk to Dawn Activated Flood Light with Adjustable Color Temperature

★★★★★ Write the first Review Ask the first question

$96.99

Save up to $100 on your qualifying purchase.
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Fixture Color/Finish: **Bronze**

Bronze White

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Quantity - 1 +

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Delivery Options

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Live Chat

Product Overview

Introducing Color Temperature technology that allows exterior home lighting to be customized from a warm white to daylight color temperature using a simple adjustable dial located on the light. Photocell technology allows that light to operate from dusk to dawn with LED technology that provides long lasting bright energy efficient lighting for safety and security around the perimeter of the home. The light fixture has a three robust lamp head design which provides the ability to focus light where needed in large areas.

- Adjustable color temperature from warm white to daylight by simple dial control
- Operates from dusk-to-dawn only
- Bright 3100 Lumens output
- Triple lamp head design with tool-free adjustment
- Energy efficient LED technology
- Bronze finish
- 5 year warranty
- Click here for more information on Electronic Recycling Programs

Info & Guides

- Warranty

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Current Product

Heath Zenith Triple Head Outdoor Integrated LED Dusk to Dawn Activated Flood Light with Adjustable…

(0)

$96.99 each

Item Selected

Heath Zenith Twin Head Bronze Outdoor Integrated LED Dusk to Dawn Activated …

(0)

$72.58

Select This Item

1 Item Selected

Add Item To Cart

Live Chat

Shop This Collection from Heath Zenith

Live Chat

Current Product

Heath Zenith Triple Head
Outdoor Integrated LED
Dusk to Dawn Activated

Sponsored Products

PROBRITE High-Output 40-Watt Integrated LED

(126)

$127.96/package
Was ~~$159.96~~

Add To Cart

PROBRITE Architectural Round 50 Watt,

(12)

$222.40/package
Was ~~$278~~

Add To Cart

PROBRITE 14-Watt Integrated LED Area and

(3)

$111.96/package
Was ~~$139.96~~

Add To Cart

PROBRITE Bright Bronze 20-Watt Integrated LED

(5)

$95.96/package
Was ~~$119.96~~

Add To Cart

PROBI Watt Ir LED W

$103
Was ~~$12~~

Add

Live Chat

Specifications

Dimensions

Product Depth (in.)	
6	
Product Height (in.)	
4.5	
Product Length (in.)	
6	
Product Width (in.)	

13.25 in

Details

Actual Color Temperature (K)	5000
Adjustable Detection Sensitivity	No
Adjustable Lamp Head	Yes
Color Rendering Index (CRI)	84
Color Temperature	White Adjustable Light
Detection Range (ft.)	0
Dusk to Dawn	Yes
Exterior Lighting Product Type	Floodlights
Fixture Color/Finish	Bronze
Fixture Material	Plastic
Glass/Lens Type	Frosted

Included
Mounting Hardware Included
Lumens
3100
Motion Sensing
No
Number of Lights
3 Lights
Outdoor Lighting Features
Adjustable Lamp Head,Dusk to Dawn,Weather Resistant
Pack Size
1 Pack
Power Options
Hardwired
Power Type
Line voltage
Product Weight (lb.)
3lb
Returnable
90-Day
Timer Included
No
Voltage

Live Chat

Line Voltage	
Voltage Type	
Line Voltage	

Warranty / Certifications

Certifications and Listings	
ETL Listed	
Manufacturer Warranty	
5 year	

Live Chat

How can we improve our product information? Provide feedback.

Recently Viewed Items

Heath Zenith Twin Head White Outdoor Integrated

(1)

Heath Zenith Twin Head Bronze Outdoor Integrated

NOT YET RATED

/**/

Home / Lighting / Outdoor Lighting / Outdoor Security Lighting / Flood Lights

Internet #309815011 Model # HZ-8814-WH

Live Chat

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Heath Zenith

Triple Head Outdoor Integrated LED Dusk to Dawn Activated Flood Light with Adjustable Color Temperature

★★★★☆ (1) Write a Review Questions & Answers (1)

$103.78

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Fixture Color/Finish: **White**

Bronze | **White**

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Quantity - 1 +

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Delivery Options

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Product Overview

Introducing Color Temperature technology allows exterior home lighting to be customized from a warm white to daylight color temperature using a simple adjustable dial located on the light. Photocell technology allows the light to operate from dusk to dawn with LED technology that provides long lasting bright energy efficient lighting for safety and security around the perimeter of the home. The light fixture has a three robust lamp head design which provides the ability to focus light where needed in large areas.

- Adjustable color temperature from warm white to daylight by simple dial control
- Operates from dusk-to-dawn only
- Bright 3100 Lumens output
- Triple lamp head design with tool-free adjustment
- Energy efficient LED technology
- White finish
- 5 year warranty
- Click here for more information on Electronic Recycling Programs

Info & Guides

- Warranty

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Shop This Collection from Heath Zenith (2)

Current Product

Heath Zenith Triple Head Outdoor Integrated LED Dusk to Dawn Activated Flood Light with Adjustable…

(1)

$103.78 each

Item Selected

Heath Zenith Twin Head White Outdoor Integrated LED Dusk to Dawn Activated …

(1)

$77.59

Select This Item

Heath Zenith 180-Degree White Motion Activated Outdoor Flood Light …

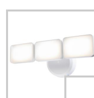
(2)

$14.54

Select This Item

Live Chat

1 Item Selected



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Sponsored Products

PROBRITE High-Output 40-Watt Integrated LED

(126)

$127.96/package
Was ~~$159.96~~

Add To Cart

PROBRITE Architectural Round 50 Watt,

(12)

$222.40/package
Was ~~$278~~

Add To Cart

PROBRITE 14-Watt Integrated LED Area and

(3)

$111.96/package
Was ~~$139.96~~

Add To Cart

PROBRITE Bright Bronze 20-Watt Integrated LED

(5)

$95.96/package
Was ~~$119.96~~

Add To Cart

PROBI Watt Ir LED W

$103
Was ~~$12~~

Add

Live Chat

Specifications

Dimensions

Product Depth (in.)

6

Product Height (in.)

4.50

Product Length (in.)

6

Product Width (in.)

13.25 in

Details

Actual Color Temperature (K)	5000
Adjustable Detection Sensitivity	No
Adjustable Lamp Head	Yes
Color Rendering Index (CRI)	84
Color Temperature	White Adjustable Light
Detection Range (ft.)	0
Dusk to Dawn	Yes
Exterior Lighting Product Type	Floodlights
Fixture Color/Finish	White
Fixture Material	Plastic
Glass/Lens Type	Frosted

Included
Mounting Hardware Included
Lumens
3100
Motion Sensing
No
Number of Lights
3 Lights
Outdoor Lighting Features
Adjustable Lamp Head,Dusk to Dawn,Weather Resistant
Pack Size
1 Pack
Power Options
Hardwired
Power Type
Line voltage
Product Weight (lb.)
3lb
Returnable
90-Day
Timer Included
No
Voltage

Live Chat

Line Voltage	
Voltage Type	
Line Voltage	

Warranty / Certifications

Certifications and Listings	
ETL Listed	
Manufacturer Warranty	
5 year	

Live Chat

Recently Viewed Items

Heath Zenith Triple Head Outdoor Integrated

(0)

Heath Zenith Twin Head White Outdoor Integrated

(1)

Heath Zenith Twin Head Bronze Outdoor Integrated

NOT YET RATED